

regional planning committee of san mateo county

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the physical setting of san mateo county



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THE PHYSICAL SETTING
OF SAN MATEO COUNTY

San Mateo County Planning Department

May 17, 1968

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regional planning committee
san mateo county

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May 17, 1968

To: Members of the Regional Planning
Committee of San Mateo County

Ladies and Gentlemen:

It gives me great pleasure to transmit to you this report entitled THE PHYSICAL SETTING OF SAN MATEO COUNTY. This volume is the first of a series of background studies being made as an integral part of the General Plan Revision Program which has been initiated by RPC. This, and the reports to follow, are intended to provide RPC members, and the interested public, with a source of factual information on which to base decisions on the optimum future development pattern for our county.

Other reports in this series are presently contemplated to include the following:

- Population Growth and Characteristics
- Economic Growth and Characteristics
- Social Relationships and Problems
- Governmental Organization
- Land Use: Past Trends and Future Requirements
- Housing Needs
- Transportation
- Park and Open Space
- Public Utilities Requirements
- Planning Issues Facing San Mateo County

Credit for the preparation of this report should be given to Fred Trull, of the San Mateo County Planning Department staff.

Respectfully submitted,

Reino Liukkonen
Planning Director

FOREWORD

This study of the physical setting of San Mateo County is a part of a long range, comprehensive research program which is intended to provide information to a wide variety of users, including private businessmen, civic organizations, members of city and county government, and all interested citizens. The purpose of this study is to analyze the natural features of the county in order to: 1) determine suitability of various areas of the county for particular land use activities, 2) delineate areas of potential hazards, and areas where more detailed study is needed, 3) formulate planning policies to guide future development in San Mateo County.

Every effort has been made to supply organized, valid, up-to-date information. A listing of source material has been included at the end of each section for those interested in more detailed information. In some instances, scientific information is limited, and is so indicated.

TABLE OF CONTENTS

<u>Chapter</u>	<u>Page</u>
SUMMARY	ix
INTRODUCTION	xii
I THE CLIMATE	1
Regional Climate	1
Temperature	2
Precipitation	4
Fog and Cloud Cover	10
Air Pollution	15
Wind	17
Wind Movement and Human Comfort	19
Influence of Wind on Land Use Activities	19
Summary	21
II THE EARTH	24
Geological History	24
Topographic Characteristics	24
Land Forms	26
Topography as an Influence on Urban Settlement	26
Land Slope	26
Slope Categories	31
Drainage and Flooding	34
Factors Which Affect Drainage Characteristics	34
Problem Areas in San Mateo County	37
Flooding and the Public Interest	40
Flood Damage Correction and Prevention	40
Soils	42
Erosion Hazards	44
Shrink-Swell Behavior	44
Soil Corrosivity	47
Septic Tank Filter Fields	47
Geologic Hazards	50
Earthquakes	50
Special Problem Areas	52
Conclusions	53
Landslides	54
III THE MINERALS	62
Shells	65
Sand, Gravel, and Rock	67
Salt	69
Bromine	70
Oil and Gas	70
Bituminous Rock	71
Clay	72
Chromite	72
Silver	72
Gold	73
Semi-precious Gem Stones	73

IV	THE VEGETATION	76
	Plant Zones	76
	The Cultivated Plant Setting	79
	Urban Plants	79
	Growth Requirements	79
	Agriculture	81
	Resource Potential	84
	The Primeval Setting	87
	Conifer Forest	88
	Broadleaf Forest	91
	Grasslands	92
	Marshlands	93
	Semi-Barren Lands	93
	Resource Potential of the Primeval Setting	93
V	RECOMMENDED GENERAL POLICIES	96
	Policies Concerning Climate	96
	Policies Concerning the Earth	98
	Policies Concerning the Minerals	99
	Policies Concerning the Vegetation	100

LIST OF PLATES

<u>Plate</u>		<u>Page</u>
I	San Mateo County Landform Influencing Precipitation Distribution	5
II	Average Annual Rainfall	8
III	Early Morning Cloud Cover (fog)	11
IV	Afternoon Cloud Cover (fog)	12
V	Peninsula Climates	22
VI	Generalized Land Slope	33
VII	Drainage Basins	35
VIII	Areas of Historical or Potential Flooding	38
IX	Erosion Hazard	45
X	Shrink-Swell Behavior of Soils	46
XI	Soil Corrosivity	48
XII	Suitability of Soils for Septic Tank Filter Fields	49
XIII	Earthquake Faults	51
XIV	Landslide Areas	56
XV	Mineral Resource Areas	63
XVI	Vegetation Types	77

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Average Temperatures at Selected Sites in San Mateo County and Vicinity	3
2. Average Annual Precipitation in San Mateo County and Vicinity . .	6
3. Altitude as an Influence on Average Annual Precipitation in. . . . San Mateo County and Vicinity	7
4. Expected 24-Hour Rates of Rainfall, and Average Annual Rainfall . 7 for San Mateo County	
5. Average Number of Clear Days per Year for Selected Sites in. . . 10 San Mateo County and Vicinity	
6. Percentage Monthly Occurrence of Wind Direction	18
7. Indoor Wind Speed and Human Comfort	19
8. Theoretical Storm Water Discharge by Types of Development . . .	36
9. Urban Place in San Mateo County with Flood Problems	39
10. Mineral Production in San Mateo County	64
11. Agricultural Land Use in San Mateo County	82
12. Agricultural Production Values	83
13. Timber Production in San Mateo County, 1965	88

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Fog build-up along the coastside of San Mateo County	13
2. Stratus clouds or fog cascade, over the Coastal Mountain Range	13
3. Fog in the redwood forest	13
4. Stable wind conditions contribute to the build-up of smog . .	16
5. Topographic map of San Mateo County	25
6. The bayside of San Mateo County	27
7. The coastside of San Mateo County	27
8. Beach and coastal terrace	28
9. Coastal foothills	28
10. The mountains of San Mateo County	28
11. View looking into an upper valley	28
12. Bayside foothills	29
13. Bayside plains	29
14. Bayside marsh and mudflats	29
15. Man-made features become predominant	30
16. The Reshaping of County foothills	30
17. Hydraulic fill operation	30
18. Backyard activities are limited by land slope	32
19. Man-made structures adjusted to steep slope	32
20. Devils slide area	32
21. A hillside subdivision	32
22. Street damage by the Vista Verde Way landslide	55
23. Structural damage caused by landslide	55
24. Causes of landslides	58
25. Oyster shells being removed from a barge	66
26. Salt storage in Redwood City	66
27. The urban environment with a minimum of plant materials . .	80
28. Flower cultivation in an agriculture setting	80
29. Grasslands of San Mateo County	86
30. The beginning of the chaparral zone	86
31. The conifer forest provides a unique recreational setting . .	90
32. A roadside view of the broadleaf forest	90

SUMMARY: THE PHYSICAL SETTING OF SAN MATEO COUNTY

Chapter I THE CLIMATE

Temperature: The average summer and winter temperatures are 66° F. and 48° F. respectively, with an annual mean of about 57° F. Peak extremes have ranged from 16° F. to 106° F., however, freezing temperatures are seldom recorded and only about three days per year have temperatures above 90° F.

Precipitation: About 74% of the total annual precipitation occurs during the four months of December through March. Precipitation distribution ranges from about fifteen inches at sea level to fifty inches at elevations above two hundred feet.

Cloud and Fog Cover: Cumulus and stratus (fog) clouds cause cloudy conditions 140 days per year. Incidence of fog, principally on the coast, is almost five times as frequent in the period of November to February as the rest of the year.

Air Pollution: Air pollution is most likely to occur for about fifteen per cent of the winter and practically all summer when temperature inversions "cap" air over the San Francisco Bay. At such times, ocean breezes are weak and provide too little ventilation to offset the rate at which generators are emitting pollutants.

Wind: The general prevailing wind is from the west, a light to moderate flow. A few rainy, winter days may have gale force winds (30 to 60 m.p.h.) and very infrequently hurricane force winds (70 m.p.h.).

Climate is determined by the prevailing or averaged conditions of temperature and meteorological changes of a place over a period of years. It is influenced by world-wide factors such as latitude, rotation of the earth, and the inclination of the earth on its axis. It is also influenced by more localized factors of altitude, topography, ocean currents, suspended particles in the air and the distribution of land and water surfaces. At least five micro-climates can be identified and mapped within the county because of these localized differences.

The climate of the county influences life styles that are attractive for the residents, for industry, and for visitors. Planning implications involve the location of human activity areas to avoid or to control environmental factors creating glare and amplified heat problems, pollution of air and water, exposure to strong winds which convey noise, fumes, and smoke. Urbanization in areas of high precipitation can be expected to create problems in run-off and flooding. Alteration to topography or filling as much as 25% of the bay can be expected to cause higher summer temperatures, reduce rainfall in adjacent valleys and to increase the frequency and thickness of both fog and smoke in the Bay area.

Chapter II THE EARTH

The geological evolution of the Bay area produced at least eight significant land forms; the ocean beach, the coastal terrace, the coastal foothills, the mountains, the upper valley, the bayside foothills, the bayside plains and the bay marsh and mudflats. Thus, the 553 square mile area of San Mateo County contains a wide variety of geological conditions which influence human activities.

Land Slope: Major industrial, commercial, educational and transportation facilities need reasonably level land, in order to keep grading cost to a minimum

and to provide enough space for large structures and parking areas. Agricultural activities can utilize relatively flat land for irrigated crops and steeper slopes for dry farming. Residential areas utilize a variety of sites to provide a wide selection of housing types. Very steep slopes are best utilized for wildlife, forestry and limited grazing. Greater difficulty in building generally occurs with steepening slopes which usually have shallow top soils and rocks close to the surface so that drilling, excavation, soil erosion and landsliding are frequent problems.

Drainage and Flooding: The drainage characteristics of the county are determined by conditions of climate, soil, plant cover, extent of urban development and land slope. The processes of urbanization alters the natural hydrologic system with grading activities and the construction of impermeable surfaces thereby increasing the rate, volume and purity of the draining water. The pressures of urbanization have pushed development into low lying areas which were originally by-passed due to poor drainage characteristics on flooding hazards. Flooding is a recurring problem in at least 14 urban places and several rural watershed throughout the county.

Soils: Soil provides the floor and foundation for all of man's activities. Ideally, sites for industrial, residential, commercial and intensive recreational activities are characterized by deep, well-drained, permeable soil on gentle slopes. However, some of the areas have slope and climatic characteristics which are favorable for urban development but their frail soils create development problems. Erosion hazards, shrink-swell behavior, bearing strength, depth to rock, depth to water table, plant material cover, depth of topsoil and percolation rate are some of the soil characteristics that influence site suitability and the design, construction and cost of man-made structure. The recognition that a particular soil is prone to fail in one area or another is a valuable aid in long-range planning and in the evaluation of all potential urban sites.

Earthquakes: The major seismic hazard region of the United States appears to be centered through California and Alaska which have more earthquakes and damages than all the other states. Investigations of past earthquakes have provided evidence to conclude that some land areas within an earthquake region are more stable than others. High risk locations are in the narrow fault trace zone, on alluvium soils, beach sand and dunes, hillside sites, the surface of relatively old landslides, and in areas with underlying unconsolidated bay mud. San Mateo County can anticipate earthquakes in the future and should seek planning techniques for reducing potential destruction.

Landslides: The great influx of people into the state and into the county within the last decades has intensified the rate at which urban development is occurring in hilly and mountainous areas. Development layouts that are suitable for level areas frequently upset the delicate balance of the slopes and trigger landslides when tried in hilly areas. Unless hillside development is carefully managed, damage to property, perhaps even loss of life, can be expected to occur due to an increased slide incidence of many of the fragile-soil hillsides.

Chapter III THE MINERALS

Records indicate that mineral commodities produced in San Mateo County in the past have included semi-precious gems, potash, mercury, gold, silver, platinum, bituminous rock and common clay. Principal mineral commodities presently produced include salt, magnesium compounds, sand and gravel, oyster shells, petroleum and natural gas.

The demands for mineral resources are rapidly growing as a result of national defense needs and an increasing population accompanied by a rising standard of living. Fluctuating factors - the cost of mining and processing; the cost of marketing and the demand for the commodity - determine the economic value of a mineral resource.

The distinctive characteristic of mineral economics which creates problems both in concepts of land utilization and execution of resource development, is that once a non-renewable mineral resource is exhausted it can not be replaced. With the depletion of high-grade mineral deposits, it will be necessary to develop lower-grade deposits, particularly those that give promise of yielding more than one commodity. Since many mineral extraction activities are not compatible with, or are prohibited in the present urban setting, there is a pressing need to identify, hasten extraction or preserve resource sites which could be pre-empted by urbanization.

Chapter IV THE VEGETATION

The evolutionary processes of plant invasion and succession, as influenced by climate, soil, topography, man's treatment of the land, and other factors, have combined to form a diversified and complex pattern of vegetative types throughout San Mateo County. The county's plant resources may be classified into two major settings: 1) the cultivated setting, either urban or rural, where man's activities are predominant determinants of plant types, and 2) those areas where natural growth patterns are dominant.

Those plants that can grow and meet the needs of the urban setting enhance the aesthetical qualities of urban living and serve to reduce climatic extremes of heat, wind and aridity. A special complication peculiar to the vegetative types growing in the semi-arid climate of San Mateo County is the problem of fire. In the dry season, the scattered and intermittent large lot dwellings and summer home developments in rough topography are most vulnerable to brush fire.

Agricultural activities are generally restricted by suitable soil, irrigation water supplies, the fog belt and steepness of slope. Shifts in land use away from agricultural to urban uses have been influenced by: 1) the diminishing supply of land available for urban development located close to population centers, 2) the high development cost of close in locations, and 3) improvements in transportation systems to areas previously inaccessible. Damage to flower crops from air pollution has encouraged many flower producers to move from the bayside of the county to the coastside where air pollution is thought to be less severe.

The natural setting is usually destroyed as the urban areas encroach into the countryside and change the natural ecological system of ground forms, rocks, plants and water. These natural plant settings have been divided into six major vegetation type areas: conifer forest, broadleaf forest, grasslands, chaparral, marsh lands and semi-barren lands.

The conifer forest is probably of most economical significance due to its value for producing saw timber and Christmas trees. The redwood groves are a unique resource for recreational activities.

Chapter V RECOMMENDED GENERAL POLICIES

These statements are a form of summation and are not included in this summary.

INTRODUCTION

The natural environment sets many subtle restrictions on man's activities and his use of land. Large portions of the earth's land area are restricted because they are too steep, too dry, too hot, too cold, too wet or too hazardous to provide the food and fiber necessary to support the advancement of civilization. San Mateo County is within a relatively small area where physiographic conditions are highly favorable, but the county is not without problems.

An incomplete listing of the county's physical setting problems includes: recurring flooding in both the agricultural and urban areas, an inadequate water supply to support additional urbanization on the coastside, the pollution of water and air, the loss of valuable minerals by urban encroachment, the destruction of valuable trees, increasing instances of landsliding, and the threat of earthquakes.

An analysis of the county's problems can follow several systematic investigation processes. For the purposes of this report, the investigation process will generally examine the county's ecological system.

Ecology is generally described as the study of the interdependence of man with nature. The discipline of ecology provides a systematic approach for examining environmental processes which introduce certain opportunities or constraints upon human activities and metropolitan growth. Ecological principles have practical application for predicting effects on food production, water quality, cleanliness of the air, climatic alterations, cultural life styles and effects on man's psyche, economic and physical well-being.

The ecological approach seeks to uncover facts and principles that pertain to the relationship of man to his environment so that the impact of man on his environment, and vice versa, can be identified and measured. If the activities of man modify the ecological system by changing the quantity of any part of the system, it is likely that the change will have direct effects on numerous organisms, including man. By altering the characteristics of the land and by discharging gases and particles into the air, man both intentionally and unintentionally modifies the environment in which he lives. Intentionally, clouds may be seeded to produce rainfall. Unintentionally, large industrialized cities produce "heat islands" in the atmosphere directly above them which may reduce the amount of solar radiation and may increase cloudiness, precipitation, temperature and contaminants as compared to adjacent rural areas.

A major purpose of land-use planning is the evaluation of the advantages and disadvantages of one use of land as compared to another. The evaluation, of course, must be based on as many measurable factors as possible so as to make the best planning decisions for the optimum use of the land.

To a significant degree, the characteristics of the earth's materials determine how land can be most effectively and safely utilized. The identification of hazards as done by large scale mapping long before urbanization occurs can be utilized to guide development toward an optimum urban pattern. Temperature, precipitation, wind, soil, plant growth, animal life, topography and drainage interact to establish an underlying order. These factors affect the use capabilities of the land and influence man's activities in regard to using, misusing or reusing the land. An analysis of the ecological system reveals areas that are best suited, marginal or poorly suited for the various land use activities.

Planning activities are concerned with recognizing and analyzing the natural hazards and seeing to it that man-caused troubles are limited. It is within human power to control or even prevent many of these recurring calamities.

It is hoped that this report will promote a wider understanding of the physical setting of San Mateo County so that we who live and build here can preserve the quality of our environment as the county grows and changes.

Sources of Additional Material

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chapter 1

the climate



REGIONAL CLIMATE

Climate is determined by the prevailing or averaged conditions of temperature and meteorological changes of a place over a period of years. Climate is distinguished from weather in that weather denotes the general conditions of the atmosphere at a particular time and place. A description of the climatic characteristics for an area as large as the county must be made as over-all generalizations conditioned by the realization that there are numerous small-area exceptions. For the purposes of this report, "macro-climate" will be used to identify the generalized climatic conditions of the entire county and "micro-climate" will be used to denote the numerous, significant small areas.

Regional climate is influenced by world wide factors such as latitude, rotation of the earth and the inclination of the earth on its axis. It is influenced by regional factors of altitude, topography, ocean currents, suspended particles in the air, and the distribution of land and water surfaces. The highly variable climatic patterns within the county are determined by the complex relationships of these natural phenomena.

The source of practically all energy for the earth and the atmosphere is solar radiation, which is largely absorbed when it strikes land surface.

Land surfaces experience greater variations in temperature than water surfaces. This relationship of adjacent land and water surfaces around San Mateo County - the Pacific Ocean on the west, the San Francisco Bay on the east and the Santa Cruz Mountain Range on the north and south in addition to the Sierra Nevada Mountains further east - are very influential in determining climatic conditions. The climatic condition on the bayside of San Mateo County for example, could be altered by reduction in the size of San Francisco Bay. Preliminary investigations indicate that if a major portion (about 25% or more) of the Bay were filled for urban development, the following changes in micro-climates within a few miles of the fill could be expected:¹

1. A reduction in the strength and range of the cooling summer sea breeze moving across the Bay Area.
2. Temperatures would increase or decrease respectively for summer and winter by 2° F. to 5° F.
3. More smog would occur.
4. The frequency and density of winter fog would increase.
5. Rainfall in the Santa Clara Valley area would decrease.

Such climatic changes would affect a large majority of the population of San Mateo County who are concentrated on the bayside.

The predominant northwesterly winds acting on the ocean surface results in upwelling of cold deep water (about 50° F.) along the coast. The upwelling serves to further cool the moist ocean air. If this air is close to the saturation point fog may develop. Due to vertical stability of upper air masses, the ocean air generally does not extend upward above 1,500 feet so it is usually restricted from flowing eastwardly across the entire county by the Santa Cruz Mountains. The ocean breeze, modified in temperature and velocity by the type of surfaces over which it flows, enters the county's bayside through gaps in the mountain range. The air comes through the Golden Gate gap at sea level, the San Bruno gap at an elevation of about three hundred feet, and through the Crystal Springs gap at an elevation of about five hundred feet. Although these maritime influences fade quickly as the air moves east and south over the county, it generally moderates summer and winter temperatures.

TEMPERATURE

Dry mild summers and moist, cool winters characterize San Mateo County's macro-climate. Table 1 is a generalized summary of temperature readings from several weather stations in or near the county.

The annual mean temperature derived from Table 1 is about 57 degrees. The average annual maximum temperature reaches about 66 degrees and the average annual minimum temperature approaches 48 degrees. Peak extremes for daily temperatures have ranged from a summer high of 106 degrees to a winter low of 16 degrees. Such extremes, however, are rare.

In the winter season a few morning frosts may occur in December, January and February. January is generally the coolest month but the minimum temperature is seldom below freezing. Winter daytime temperatures are generally in the fifties.

The summer season is generally sunny and warm, especially the highly populated bayside of the county, with only about three days per year with temperatures above 90 degrees. At such times, hot air from the valleys to the east overcome the prevailing cool westerly breezes. Summer warmth is tempered both by morning fogs and by afternoon sea breezes.

Temperature deviations influence the life style of the inhabitants of the county. The mild temperatures of San Mateo County give the area an advantage in the economic battle of attracting industry and employment opportunities, as compared to areas of more severe weather extremes. The mild temperature serves as a lure for those people desiring summer living all year around and for those seeking a mild climate for seasonal residences, and vacations.

Generally people are comfortable in a temperature range of about 65 degrees to 70 degrees. When temperatures drop below 65 degrees humans become uncomfortable without additional clothing or heating. Climatic data collecting techniques utilize a "degree day," which is the difference between the average temperature on a given day and 65 degrees, to indicate these cool periods. For example, San Diego, located in a warm climate, annually approaches 1500 degree days, as compared to roughly 3400 degree days in San Francisco. These figures are frequently utilized to calculate heating and fuel consumption needs.

Warm weather conditions, when temperature exceeds 70 degrees, are expressed as cooling degree days. September, the warmest month, approaches an average maximum of 72 degrees. The relatively cool summer of San Mateo County is reflected by the general absence of air conditioning equipment in homes and automobiles.

Due to the mild winter season in San Mateo County, the depth of frost penetration into the earth is not an influential factor requiring excavation and subsurface preparation for water lines, roads and building foundations to prevent damage from freezing and frost-heave action. Steep grades for roads may be used since icy or freezing conditions do not affect automobile braking or stopping action.

TABLE 1: AVERAGE TEMPERATURES AT SELECTED SITES IN SAN MATEO COUNTY AND VICINITY
(in degrees Fahrenheit)

Location	J	F	M	A	M	J	J	A	S	O	N	D	Average			Record Extremes	
													Max.	Min.	Ann.	High	Low
Half Moon Bay	50	50	52	53	55	57	58	59	59	56	54	51	62	47	55	93	27
San Francisco (airport)	48	51	53	54	57	60	61	61	62	60	54	50	65	47	56	97	30
San Francisco (civic center)	50	53	54	56	57	59	59	59	62	61	57	52	63	50	57	104	20
San Mateo City	49	52	54	57	60	64	65	65	65	62	56	51	69	48	58	104	23
Redwood City <i>Mar. 1961</i>	48	51	54	57	61	65	68	67	66	61	54	50	71	46	59	106	16

Source: Calculated from U. S. Department of Commerce, Weather Bureau (See footnote 2)

PRECIPITATION

Regional Aspects

In the summer season, transoceanic rain storms approaching the coastline are deviated by the Pacific high pressure area and are prone to hit the coast north of the county in the states of Oregon and Washington. Occasionally the storm's southern fringe may hit the county. Other rare summer showers usually come from the south, when an erratic mass of warm, moist air moves into the area from the Gulf of Mexico. These storms are infrequently accompanied by thunder and lightning.

When the Pacific high moves southward in the winter, moisture laden storms moving eastward from the Pacific Ocean can move inland but must pass over several valleys and mountain ranges. Each successive valley has less of a damp seacoast climate and more of a dry continental climate which generally trends to get hotter in summer and colder in winter. This general trend may be modified by gaps in mountain ranges and large bodies of water, such as the San Francisco Bay. None the less, the motion of moisture laden winds that blow upward over the Santa Cruz Mountains, downward over the bay and upward over the Diablo Range influence regional precipitation volumes. A maximum amount is dropped on the wind-cooling upward movement, but a minimum amount, referred to as rainshadow, is dropped on the air-warming downward motion. Plate I illustrates the influence of generalized topographic features on precipitation distribution.

About 74% of the total annual precipitation for San Mateo County occurs during the four months of December through March (see Table 2).

Precipitation is generally associated with the west to east passage of low pressure areas and their frontal systems. However, during the course of a single storm, rain usually comes from several directions. Most precipitation occurs in the air flow from the southwest which usually proceeds the low pressure areas. Some precipitation in the form of squalls may occur as the wind shifts to flow from the northwest following the passage of a storm system.

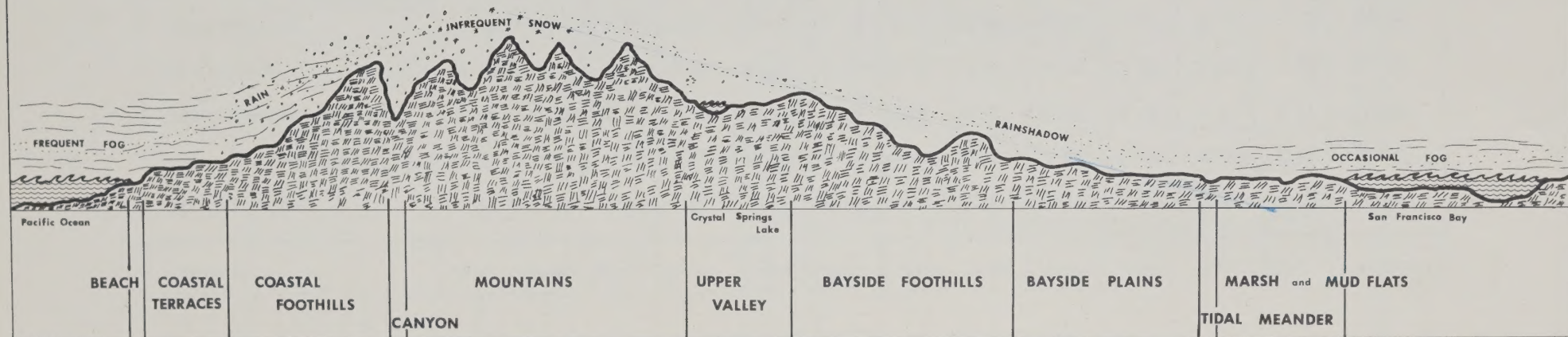
Precipitation patterns create complex micro-climates throughout the county which are frequently supplemented by sources of moisture other than rain. Deep west-facing canyons are often shrouded in mist many days of the year especially in winter when low clouds prevail at higher elevations. In summer fog blows in from the ocean. Stands of trees in a foggy area not only collect drops from fog blowing directly into the grove but tend to create turbulent eddies causing air to circulate downward. Thus, fog droplets collect in increased amounts.

In San Mateo County precipitation generally increases with altitude ranging from an annual low of about fifteen inches at sea level to an annual high of about fifty inches in elevation above two thousand feet. The influence of elevation is indicated in Table 3.

Occasionally snow falls in these high areas but remains only a short time and is inconsequential as a source of precipitation. The high precipitation areas, illustrated on Plate II, are located near the summit of the Santa Cruz Mountain Ridge running down the center of the county. Pronounced precipitation differences are noticeable in a distance of less than ten miles transversing east to west across the county.

PLATE I

San Mateo County Landform Influencing Precipitation Distribution



scale: horizontal 0 5000' vertical 0 200' delineated by: Trull date: 3/68

SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

TABLE 2
AVERAGE ANNUAL PRECIPITATION IN SAN MATEO COUNTY AND VICINITY

Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Half Moon Bay	4.27	4.38	3.44	1.87	0.68	0.20	0.02	0.01	0.11	1.48	2.66	4.34	23.46
San Francisco (city)	4.71	3.64	3.04	1.52	0.66	0.15	0.01	0.02	0.27	0.93	2.37	4.45	21.77
San Francisco (airport)	3.90	3.03	2.67	1.17	0.35	0.13	0.01	0.02	0.08	0.68	1.56	4.17	17.77
San Mateo	4.66	3.55	3.39	1.46	0.58	0.13	0.01	0.01	0.27	1.08	2.22	3.45	20.81
Redwood City	4.08	3.76	2.83	1.21	0.45	0.12	0.02	0.03	0.06	0.95	1.74	3.70	18.95
Monthly Average	4.32	3.67	3.07	1.45	0.54	0.15	.014	.018	0.16	1.02	2.11	4.02	20.55
Monthly Per Cent	21.02	17.9	14.9	7.1	2.6	0.7	.06	.09	0.8	4.95	10.3	19.5	100.00

Source: U. S. Department of Commerce, Weather Bureau

TABLE: 3
ALTITUDE AS AN INFLUENCE ON AVERAGE ANNUAL PRECIPITATION
IN SAN MATEO COUNTY AND VICINITY

Station	Elevation	Average annual precipitation
San Francisco Airport	8 ft.	17.77 in.
San Mateo	30	20.81
Redwood City	31	18.95
Half Moon Bay	36	23.46
Pigeon Point Lighthouse	50	21.56
San Francisco (city)	52	21.77
Souza Ranch	250	25.58
Crystal Springs Lake	300	27.25
San Andreas Lake	377	35.82
Portola State Park	420	54.56
Cuesta La Honda	450	26.97
Pilarcitos Lake	695	45.34
Skylonda	1,450	48.72
Saratoga Gap	2,600	53.93

Sources: U. S. Department of Agriculture Soil Conservation Service
U. S. Department of Commerce, Weather Bureau

Anticipated intensity of rainfall in a twenty-four hour period is presented in Table 4. It can be noted from this table that in those areas where the average annual rainfall is 22.5 inches, an intensity of 2.08 inches can be expected once in five years, 2.54 inches once in ten years, 3.10 inches once in twenty-five years, and 3.36 inches once in fifty years.

TABLE: 4
EXPECTED 24-HOUR RATES OF RAINFALL AND
AVERAGE ANNUAL RAINFALL FOR SAN MATEO COUNTY

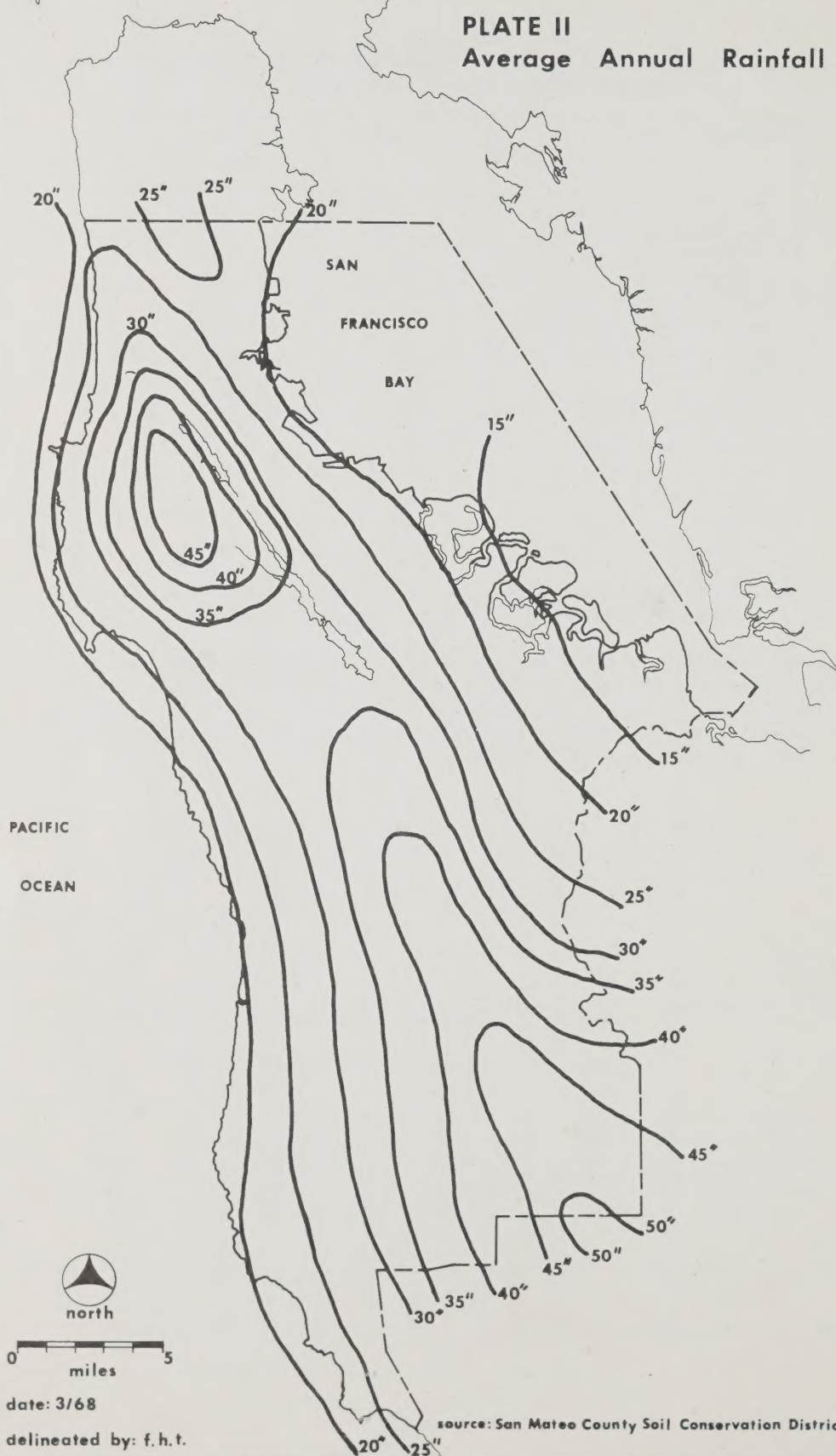
FREQUENCY OF 24-HOUR RAINFALL				
Average annual rainfall	Once in 5 years	Once in 10 years	Once in 25 years	Once in 50 years
Inches	Inches	Inches	Inches	Inches
17.5 -----	1.60	1.98	2.40	2.60
22.5 -----	2.08	2.54	3.10	3.36
27.5 -----	2.53	3.10	3.80	4.85
32.5 -----	3.00	3.67	4.50	4.85
37.5 -----	3.45	4.23	5.20	5.62
42.5 -----	3.92	4.80	5.90	6.38
47.5 -----	4.37	5.36	6.56	7.12

Source: Soil Conservation Service

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PLATE II

Average Annual Rainfall



Even though the over-all rainfall is light, the county's precipitation characteristics concern at least two aspects of regional planning: 1) water resources and 2) storm water runoff.

The availability of water is obviously crucial to any kind of development, whether it is rural, suburban or urban. Regional land planning must be closely related to water resources planning so that the water supply, in terms of both quantity and quality, will continue to meet the needs of San Mateo County. Although local precipitation is a minor contributor compared to the amount of water imported by pipeline to meet the water demands of the peninsula, local rainfall does feed the county's ground and surface water resources. Sanitary protection over the county's watersheds must continue to control pollution. Clean water is needed on the county's coastside where many agricultural activities are dependent upon surface runoff as a supply of irrigation water to avert drought conditions. Regional planning must continue to insure good quality watershed areas for existing open storage reservoirs, such as the Crystal Springs Lake and for planned water resource areas such as the Pescadero Creek project.

The maintenance of quality water supplies in the future could become a problem of increasing complexity. The expansion of urbanization reduces the amount of precipitation returned to the soil because ever greater areas of the ground are covered with buildings and streets. This process, along with increasing water consumption, may so lower the water table that the reliability of well supplies is endangered. To the south of San Mateo County, in the vicinity of San Jose, land subsidence has occurred in areas underlain by dense clay where there has been excessive pumping and drawdown of the subsurface water levels. Another effect of excessive drawdown has been the intrusion of salt water from the Bay into the subsurface water storage areas, such as in the Fremont area, thereby destroying the fresh water source.³

The rainfall from the typical winter storm and the probable intensity of the extreme storm make attention to storm drainage and flooding problems a necessary element of regional planning. Natural drainage channels and volumes of runoff are altered by urbanization. Natural drainage channels frequently must be realigned and storm drains, gutters and streets must be designed to drain rain water. Concentrated urban development must be kept out of areas with flooding problems. The high rainfall areas of upper mountain drainage areas on the bayside of the county have been largely urbanized within the last thirty years and have been accompanied by an increase in storm and flood runoff. These precipitation-related problems are further discussed in this report in the section on Drainage and Flooding.

FOG AND CLOUD COVER

There are two major influential types of cloud formations which are prominent enough to either cast shadows or effectively screen out the sun in the county area. In late winter and early spring, cumulus clouds may be seen rising above the surrounding mountains to the south and east. Probably of more notice are stratus clouds, which form in layers at any altitude. Stratus at ground level is fog. In winter, morning marsh or "tule" fogs occasionally cover the bayside lowlands. In summer, there is a high incidence of fog along the coast, and at night, as the interior cools, fog is able to penetrate over the bay. The average number of clear days for four stations, either in or adjacent to San Mateo County is listed in Table 5.

TABLE: 5
AVERAGE NUMBER OF CLEAR DAYS PER YEAR
FOR SELECTED SITES IN SAN MATEO COUNTY AND VICINITY

STATION	J	F	M	A	M	J	J	A	S	O	N	D	Total Annual
San Francisco civic center	11	10	12	14	14	17	15	13	15	16	14	11	162
San Francisco Airport		9	9	10	10	14	17	22	22	19	16	10	168
San Mateo City	13	12	16	20	26	26	29	28	26	23	20	12	251
Redwood City	11	10	12	15	20	23	29	28	25	20	17	12	222

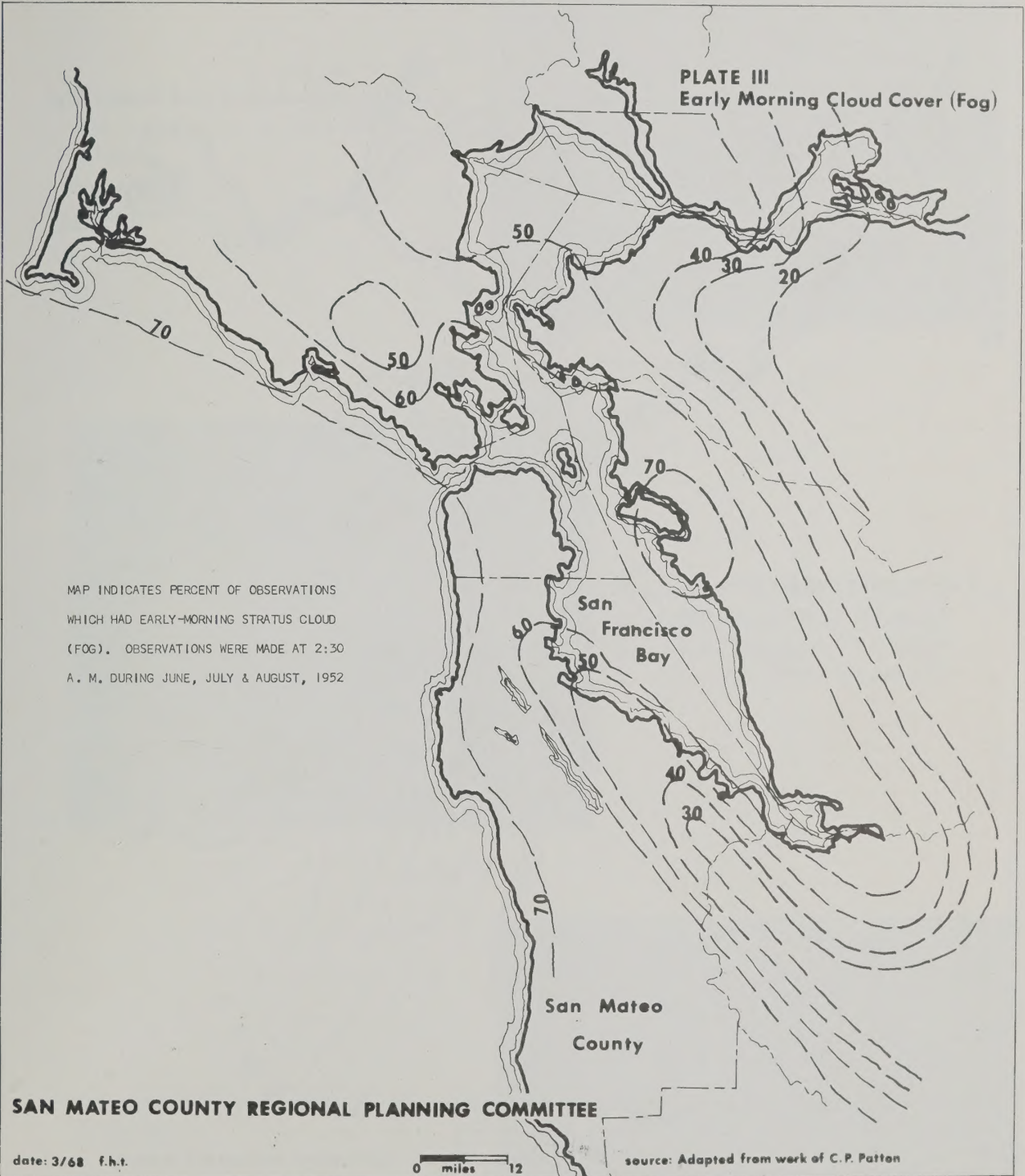
Source: U. S. Department of Commerce, Weather Bureau

Although the principal adverse feature of the county's climate is frequently cited as fog, it does help maintain moderate temperatures throughout the year. Fog incidence is almost five times as frequent in November to February as the rest of the year. Incidences of fog are principally coastal, and decrease sharply from offshore Farallon Island with an incidence of thirteen per cent of the time, to San Francisco with five per cent, to Oakland with two per cent. Fog signals at the Golden Gate operate an average of one thousand hours annually, five hundred at Alcatraz Island and two hundred at Mare Island.⁴ Fog moving eastward is usually dissipated or lifted off the ground by an increase in temperature. On the coast-side, just south of Pigeon Point where the coastline curves eastward, temperatures are generally warmer and there are generally fewer days of coastal fog. Observations on summer morning and afternoon fog patterns are graphically illustrated on Plates III and IV.

When damp air is near the saturation point, but condensation has not yet occurred, anything that lowers the air temperature a few degrees can cause condensation to take place. Fog forms whenever the air is cooled to a point where it can no longer retain all of its water in gaseous form.

Coastal fog may form in a manner similar to that shown in Figure 1, when the cool, moisture laden ocean air comes in contact with the upwelling, cold water surface along the coast. The air is further cooled and water vapors begin to cling to minute suspended particles in the air, such as dust or salt from ocean spray. Fog blankets gradually build up from thin finger-like vapors drifting inland and merge into a mass creating a cascade like that shown in Figure 2. On a westerly wind, the fog moves up coastal canyons in early morning and late

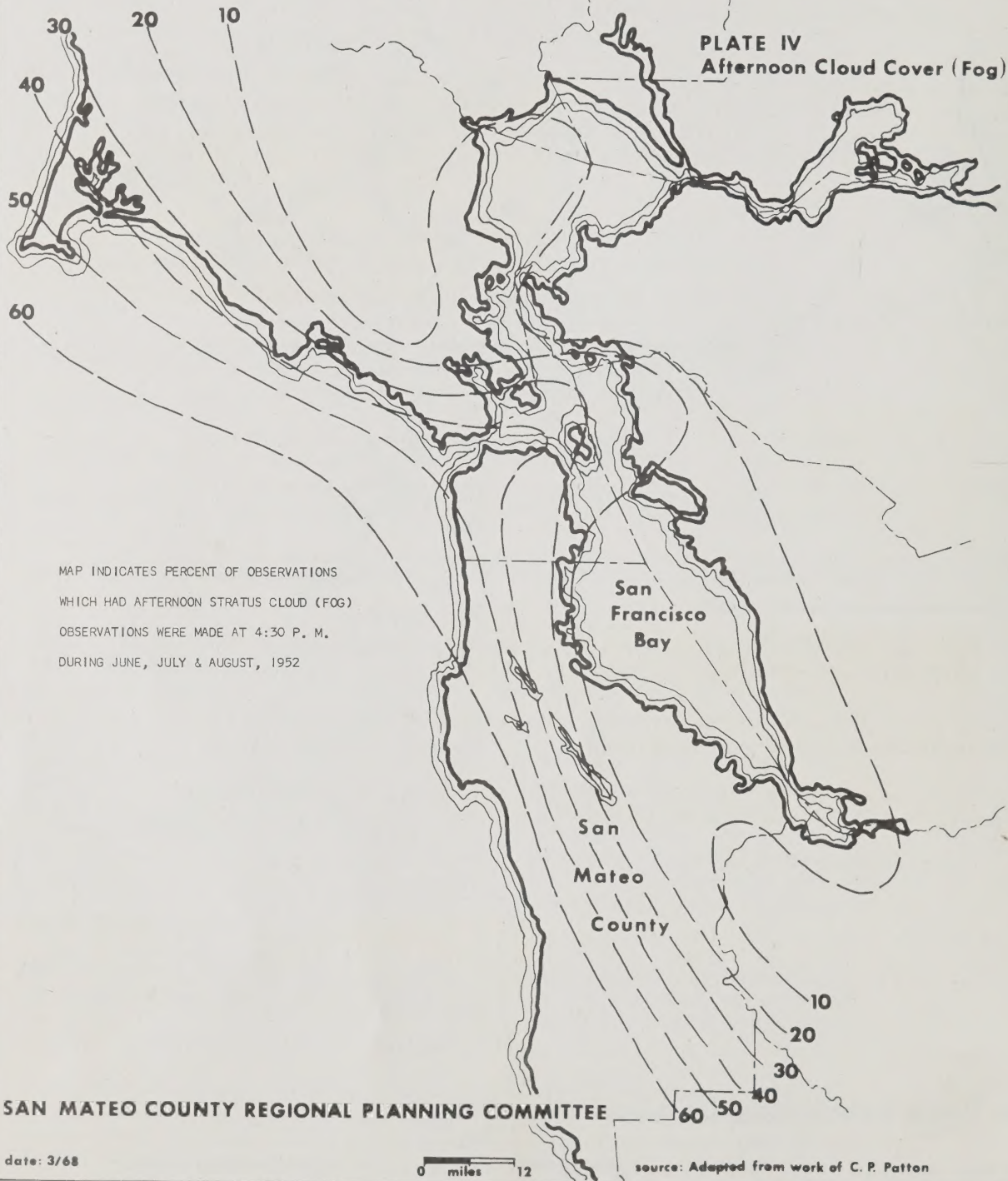
PLATE III
Early Morning Cloud Cover (Fog)



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date: 3/68 f.h.t.

PLATE IV
Afternoon Cloud Cover (Fog)



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date: 3/68

Figure 1: Fog build-up along
the coastside of San Mateo
County



Figure 2: Stratus cloud or fog
cascade, over the coastal
mountain range

Figure 3: Fog in the Redwood
Forest



evenings when the sun can't burn it off. As it moves into cooler upper mountain canyons, the vapor condenses on branches of trees, especially redwoods, and drips to the ground thereby increasing ground moisture content. These conditions are well suited for redwoods (see Figure 3) which seldom grow beyond the range of this coastal fog. The higher ridges of the coastal Santa Cruz Mountains and the vertical stability of the atmosphere frequently stop fog penetration from moving eastward across the county. However, the fog frequently moves through the mountain chain at the Golden Gate gap, the San Bruno gap and the Crystal Springs gap.

On the bayside of the county, especially during long winter nights, fog may occur when moisture-laden air is cooled through contact with ground surfaces losing its heat rapidly by radiation to space. Fog formation has also been noted when clear air near the saturation point over the bay has been cooled a degree or two by reversals of tidal currents beneath it.

AIR POLLUTION

The conditions which make for the mild macro-climate also establish a stable stratification of air, temperature inversions, which makes the area susceptible to air contamination and smog. Temperature inversions "cap" marine air over the San Francisco Bay practically all summer, and about fifteen per cent of the winter. Warm, dry air, riding above the cool marine air at varying heights between 1,400 to 300 feet, create a layering effect in the atmosphere that is extremely stable vertically.

In San Mateo County, there appear to be two major conditions for temperature inversions. The first is caused by the downward flow of air above 2,000 to 3,000 feet along the eastern periphery of the semi-permanent high pressure area over the eastern Pacific. Even though the descending air is compressed and cooled at a rate of about $5\frac{1}{2}^{\circ}$ F. for every 1,000 feet, it is dry and warm compared to the lower, moist cool ocean air.

The second condition frequently occurs on clear nights, especially in winter, when the air is not too humid and the earth's surface loses heat at a rapid rate. As the ground cools, the air in contact with it also cools, but upper layers still retain heat. Once formed this radiation inversion behaves like any other inversion as far as its "capping" effect is concerned.

When temperature inversions create an atmospheric lid over the area, the volume of air into which pollutants can be dispersed is severely limited. Weak ocean breezes may provide too little ventilation to offset the rate at which generators are emitting pollutants. Since the low marine air cannot normally penetrate the lid, neither can the pollutants injected into this air near the earth's surface. In such circumstances, the concentration of contaminants in the air must increase. Oxidants, the index term for harmful pollutants in the air which damage health and deteriorate materials, have approximately reached a concentration of .15 parts per million when the inhabitants of San Mateo County suffer eye irritation.⁵ Estimates of the economic cost from air pollution damage to clothing, metals, buildings, crops, paints and fabrics of the nation approach \$12 billion per year or about \$60 per man, woman and child.⁶

Pollutants in the atmosphere affect the climate in that carbon dioxide, which is usually found in high concentration over cities, acts as a lid thereby preventing the earth's surface from losing heat as rapidly as it might otherwise (Figure 4). Carbon dioxide readily absorbs infrared radiation emitted by the earth's surface. The result is that these pollutants can act as a blanket, restricting the rate of heat loss from the earth's surface than might otherwise occur. Thus temperatures at the earth's surface, where man lives, are raised.

Suspended particles in the air, more noticeable over urban concentrations as smoke and dust particles, reduce transparency of the air to both the sun's incoming energy and the earth's outgoing radiation. They also provide a surface for molecules of water vapor to adhere. The greater number of particles in the air, the greater will be the number of droplets. The result is denser fog and in some instances smog. Since suspended particles are generally in larger quantities over cities than over open country, the fog over cities is denser.



Figure 4: Stable wind conditions contribute to the build-up of smog

WIND

The general prevailing wind for San Mateo County as indicated in Table 6 is from the west, a light-to-moderate flow. These west winds begin to intensify during March, April and May as the inland area of the continent is warmed by a northward moving sun. The Pacific high, which is also moving northward and usually reaches its northernmost position in July and August, distributes cool ocean air inland toward the low pressure areas of the continent. The flow of air creates a movement of ocean surface waters and creates upwelling of bottom waters which are 10 to 15 degrees cooler than the surface water. The moisture laden west winds are frequently cooled by the upwelling to form thick fog and are drawn inland, where the fog evaporates over the hot areas. The winds from ocean and bay temporarily cool the inland areas by replacing the hot air until the sun reheats the area.

In June, July and August, the sun creates temperatures in the hundred degree range in the central valley of the state. In the afternoon, when the heating effects of interior land areas reach a maximum, steady west breezes of up to twenty miles per hour frequently move inland across the county through mountain gaps. This is the time when the strongest pressure difference between the Pacific high and the interior low occurs for the summer. It produces the strongest average winds for the county, although the highest wind peaks occur in winter.

The position of the Pacific high in summer tends to produce dry conditions for San Mateo County in two ways. In the first, the semi-permanent nature of the high diverts moisture-laden transoceanic storms northward into the states of Washington and Oregon. In the second way, the high pressure area will sometimes change shape or location and move inland over the Pacific northwest. When this inland position is assumed, northeast winds from high inland plateaus are frequently created which are strong enough to repel the westerly ocean breeze. The northeast air is warmed both by its descent and by passing over warm land surfaces. It pushes dry, hot continental air through mountain gaps into San Mateo County. Although this air flow usually blows out in two or three weeks, it dries out vegetation and creates a hazardous condition for forest and range fires.

In September and October, west winds begin to fall off, upwelling currents decrease and incidences of fog and cloudiness decrease. This atmospheric stability fosters temperature inversions which tend to discourage ventilation and smog develops. Temperatures drop as the sun moves southward. The Pacific high also moves south and transoceanic storms, no longer blocked by the Pacific high, move across the county.

A few days each year, usually winter days associated with heavy precipitation, may have gale force winds ranging from about thirty to sixty miles per hour. Very infrequently, hurricane force winds of over about seventy miles per hour occur.

The movement of low pressure centers and their associated frontal systems affect the county with a frequency of about every two weeks in winter. Stormy winds exist for an average of about two days during the passage of each system. Low pressure centers approaching the coast and high pressure areas inland frequently produce southwesterly storms of gale force. After the low pressure center has passed eastward, a return of northwest winds in the county usually indicates that the storm is leaving.

TABLE: 6
PERCENTAGE MONTHLY OCCURRENCE OF WIND DIRECTION

Direction Wind From	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average
North	6.0	9.0	8.3	2.3	2.0	0.2	0.0	0.2	0.4	4.8	4.4	4.2	3.5
Northeast	6.8	9.2	4.1	0.6	0.0	0.0	0.0	0.0	0.2	1.8	4.6	12.4	3.4
East	6.7	2.7	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	1.3	6.4	1.5
Southeast	13.0	3.7	6.4	2.4	0.0	0.8	0.0	0.4	0.0	1.6	6.3	14.5	4.2
South	13.8	6.8	6.2	7.4	2.4	4.5	0.2	2.6	3.7	4.6	6.3	3.5	6.1
Southwest	6.4	4.8	7.0	9.9	5.2	6.4	6.4	5.2	7.2	7.1	1.9	2.0	5.7
West	7.1	10.5	26.2*	33.3*	42.0*	54.9*	65.3*	65.4*	43.6*	22.9	9.0	7.9	31.8*
Northwest	6.2	7.1	20.3	25.5	31.7	24.7	19.7	20.7	21.2	23.5	10.8	10.5	19.1
Light Var. or Misc.	33.7*	36.1*	20.9	18.5	16.5	8.4	8.5	5.4	22.9	33.9*	55.3*	28.9*	24.6

*Indicates prevailing direction from which winds blow for the month

Figures in table are based on four readings per day

Source: Calculations from U. S. Weather Bureau Reports

Wind Movement and Human Comfort

Free circulation of air is essential to the health and comfort of humans whether they are indoors or outdoors. While health depends on fresh air, thermal comfort depends on relative humidity, air temperature and air movement.

Most people in San Mateo County, sitting indoors in light clothing will feel relatively comfortable at temperature ranges between 65 and 70° F. as long as the humidity lies between 20 to 50 per cent. The following table indicates typical reaction to air movement.

TABLE: 7
INDOOR WIND SPEED AND HUMAN COMFORT

Air Speed in Feet Per Minute	Typical Reactions
50	Generally unnoticed but essential to comfort
50 - 100	Hardly noticeable but pleasant
100 - 200	Constantly aware but pleasant
200 - 300	Slightly aware, then annoyingly aware of draft

Source: Kevin Lynch: Site Planning (Cambridge, Massachusetts, The M.I.T. Press 1962) p. 89

Wind speed in itself has a marked effect on cooling, for example, if temperature is increased to 85° F., people sitting indoors will be comfortable in a wind speed of 200 feet per minute. Air movement within man-made structures is a product of air penetration into the structure, which may be controlled by advantageous orientation of the structure to prevailing wind direction and wind velocity.

Influence of Wind on Land Use Activities

Wind movement patterns for San Mateo County are influenced primarily by a semi-permanent high pressure area located over the eastern Pacific Ocean. Local factors, such as proximity to the ocean, atmospheric pressure gradients and topographic features - notably mountain gaps - may create erratic flow patterns inland. Generally, the frictional drag between wind and land surfaces reduces wind velocity and obstacles such as hills, vegetation and structures, serve to reduce, but roughen, the air flow.

A very influential aspect of air movement in San Mateo County becomes obvious simply by the lack of wind. Cold air, which tends to settle, may gather in topographic low areas protected from the sun to create noticeable cold, damp foggy pockets. Without wind movement, odors, smoke dust and fumes from industrial operations, refuse burning, stock farms, sewage disposal, and heavy motor traffic cling to the lands surface to create an obnoxious inescapable environment - smog.

Even with wind movement these obnoxious factors remain a concern as seasonal

wind direction changes may bring them further into man's environment instead of away from it. As a medium of conveyance, a steady direct air flow tends to carry and preserve sound waves whereas turbulent flow disperses sound. Thus, the distance one needs to be from obnoxious noise sources to remain undisturbed may vary with climatic and topographic factors.

Wind movement influences other aspects of urban development. Climatic factors are studied for years before airport sites are selected and even then, the major runway is laid out to take advantage of the prevailing wind. Frequently, urban development of wind exposed sites encounter problems in controlling dust and preventing wind erosion of top soil, which most often is very shallow on such sites. After construction activities, the re-establishment of plant cover may be difficult or even impossible. Plants must be aggressive and wind-tolerant to grow in these exposed areas.

The tendency of wind movement to shift direction with seasons also presents an opportunity to locate urban areas in sites to take advantage of warm, protected sites in winter and wind cooled sites in summer. For example, at a temperature of 32° F., in protected sites wind before it strikes a house from a speed of twelve miles per hour to three miles per hour can halve fuel consumption. In terms of another economic measurement, structures placed on windy exposed sites will cost more since thermal insulation and storm windows will be needed to control winter heat loss. The inhabitants of the area will need more protective winter clothing and generally will have less opportunity for outdoor living. Additional construction cost may be incurred by the need to erect wind barriers or planting and cultivating shelter belts.

Air movement phenomena serve to influence the recreational activities of San Mateo County residents. Air provides the energy for sailing the simple kite to the complex sailboat and sail plane. The winds action on the coast causes upwelling which makes ocean waters too cold for swimming and limits beach type activities.

Moisture carried on the wind encourages moisture-needy redwood trees into fog-wet canyons to create spectacular backgrounds for outdoor activities. The hot, drying winds of summer evaporate soil-moisture, fire crops and raise outdoor fire hazard ratings enough to temper outdoor activities with elements of caution. The dry winds limit plant types to semi-arid grasses and wind sheared trees on the coastal foothills of San Mateo County to produce distinctive landscape settings.

SUMMARY

At least five micro-climates, illustrated on Plate V, and referred to as zones on that plate, have been identified.⁷

Zone A is located in the uppermost elevations of the county's hilltop and ridge-top areas. The zone receives the maximum amount of annual rainfall for the county, generally in excess of 50 inches. Due to its high elevation, the zone has the lowest temperatures, frequently in the twenties in winter, and it also has the largest range in annual temperature. Although seasonal patterns are marked, the zone does not have severe winter cold or enervating humidity. The zone is exposed to wind and gale force winds which occur in winter. Fog frequently arrives at ground level and blots visibility.

Zone B denotes the cold-winter valley floors, canyons and land-troughs in the Coastal Ranges where, due to the fact that cold air sinks, it collects in pockets. The moderating effect of marine air on this inland area is of occasional influence in regards to temperature, but it does generally keep the humidity fairly high.



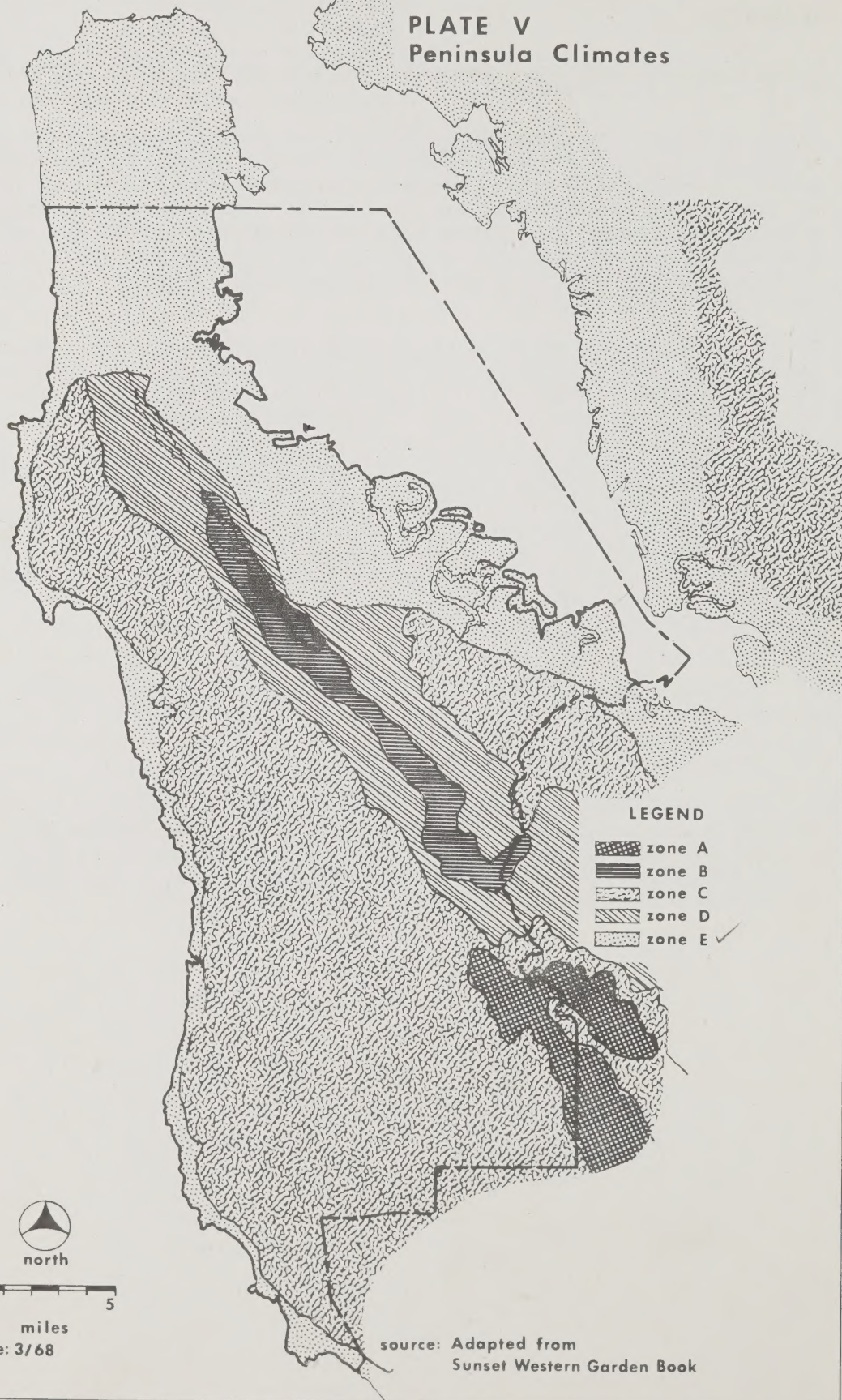
Zone C denotes a coastal climate where the ocean influences the climate approximately 85 per cent of the time and continental air influences it the remaining 15 per cent of the time. Most of Zone C gets a regular afternoon wind in summer when the winds blow from early afternoon until shortly before sunset. Piercing, cold north winds may blow for several days at a time in winter. At other times during the winter, fog may arrive and stay for hours or days. The fog generally is at ground level at night and rises to 800 feet to 1,000 feet by the afternoon. Summer daytime temperatures are high when the sun is not obscured by clouds or fog.

Zone D is also a coastal climate with approximately the same percentage influence from the ocean and continental air as Zone C. Zone D consists of the thermal belts (slopes from which cold air drains). This zone gets more heat than Zone E and also has warmer winters than Zone C.

Zone E is dominated by the ocean influence about 98 per cent of the time. The climatic features are created by a close proximity to salt water. Winters are cool and wet. Summers are cool with frequent fog or wind. Fog tends to arrive at higher elevations thus imposing a screen between the sun and earth to reduce the intensity of light, the amount of sunshine but not humidity.

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PLATE V
Peninsula Climates



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- 5 Miller, "Smog and Weather" Op. Cit.; p. 28.
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chapter II **the earth**



GEOLOGICAL HISTORY

The more significant aspects of the regional earth form surrounding San Mateo County were influenced by three major features: (1) an upthrust movement producing two mountain ranges, (2) the erosion action of a river system, and (3) an increase in the earth's ocean water volumes as a result of glacier thaw. The first significant mountain range is the Santa Cruz Range which forms the backbone of San Mateo County at an average height of 1,200 feet. Two hundred miles inland, the granite upthrust of the Sierra Nevada Mountains rise 10,000 to 14,000 feet into the atmosphere to intercept the eastern moving moisture-laden ocean winds. The mountain barrier forces the air to deposit rain and snow on the mountain slopes. This tremendous runoff joins together to form a large river system which cut a channel to the sea through the Carquinez Straits and the Golden Gate long before San Francisco Bay was formed. The melting glaciers at the end of the Ice Age caused oceans to rise, flooding these two river gorges and the inland valley to form San Francisco Bay.

There are few break points in the Coastal Range which borders the Pacific Ocean for the length of California. The most significant one is the Golden Gate gap which extends inland through the coastal Santa Cruz Mountains, through the Diablo Mountain Range just east of the Bay, and across the Sacramento Valley up to the Sierra Nevada Mountains.

Of lesser significance to the region, but very influential on the environment of San Mateo County, are two other gaps. San Bruno gap (the historic route of El Camino Real), is higher and narrower than the Golden Gate gap but provides a corridor for sea breezes and fog movement influencing the climate of the cities of South San Francisco, San Bruno, Millbrae, Burlingame and San Mateo. The Crystal Springs gap, a high valley corridor slicing through the mountains from the ocean, was partly created by the San Andreas Earthquake Fault. It serves as a corridor influencing climatic conditions on the southeast bayside of the county and further south of San Jose in Santa Clara County.⁸

TOPOGRAPHIC CHARACTERISTICS

The geographic position of the county in relation to the rest of the United States is on a latitude which generally passes through Yosemite National Park, California, Mesa Verde National Park, Colorado, Bryce Canyon National Park, Utah, Mount Vernon, Kentucky, and Richmond, Virginia. A variety of environmental relationships influenced by changing physiographic factors is revealed in both historical and present developments along this and other latitudinal comparisons.

The boundaries of San Mateo County encompass the major portion of San Francisco Peninsula (Figure 5). The county is approximately 553 square miles in total area, including about 448 square miles in land area and about 105 square miles in water area. The county is about 42 miles long and varies from approximately seven to twenty miles in width. San Mateo County is bounded on the north by San Francisco County, on the south by Santa Clara and Santa Cruz Counties, and on the east and west by the San Francisco Bay and the Pacific Ocean respectively. The length of the Pacific Ocean shoreline is approximately 55 miles and the length of the Bay shoreline is approximately 34 miles. Elevations throughout the county range from sea level to a maximum elevation of 2,572 feet, which is located about four miles east of La Honda.

The topography of San Mateo County is extremely varied. The Santa Cruz Mountain Range, with an average height of approximately 1,200 feet, extends north and



Figure 5: Topographic map of San Mateo County

south lengthwise through the county to divide it into essentially two parts, the bayside (Figure 6) and the coastside (Figure 7). San Bruno Mountain, located between San Francisco and South San Francisco, is a part of the Santa Cruz Range extending at right angles toward the bay from the main body of the range.

Land Forms of San Mateo County

The land forms of San Mateo County, already indicated by the sectional drawing of Plate I, have been categorized into eight classifications. These eight classes are encountered as one travels from the west side of the county to the east. The eight types of land forms are pictorially indicated as: (a) ocean beach (Figure 8), (b) coastal terrace (Figure 8), (c) coastal foothills (Figure 9), (d) mountains (Figure 10), (e) the upper valley (Figure 11), (f) bayside foothills (Figure 12), (g) bayside plains (Figure 13), and (h) bayside marsh and mud flats (Figure 14).

Topography as an Influence Upon Urban Settlement

Initial urban development in San Mateo County was influenced by topographic characteristics. Land use activities sought advantageous sites; manufacturing and warehousing activities settled on water-level sites, business activities occupied large level areas and residential areas occupied gentle slopes.

As settlement moved inland, the highway, and especially the railroad (powered by the steam engine which could not climb a grade steeper than two feet in a hundred), sought routes of the least topographic resistance by utilizing alignments following valley floors and alluvial plains. The introduction of the cable car permitted the development of slopes theretofore considered too steep in San Francisco. In San Mateo County, the geographic barriers of the Santa Cruz Mountains delayed construction of major transportation arteries to the coastside, but the easily accessible bayside with land suitable for urban expansion developed quickly.

Topographic problems to urban development may occur as either natural hazards inherent in the environment, or as the result of the activities of man. Technology has been continually producing earth-shaping equipment that allows for an increasingly larger scale of earth moving projects. Sites in the urban setting heretofore unutilized because of minor physiographic features may, in many instances, be reshaped for utilization (Figures 15, 16 and 17). The more accessible, urbanized and developed a site becomes, the more these man-made features become predominant over the factors of soil, topography and cover. The tendency to ignore physiographic factors is pronounced in areas where the record of land ownership is based on a grid survey system and where there is not enough variation in topography to force the land user to take site differences into consideration.⁹

To some extent, disregard for physiographic features is made possible because the consequences of violating them are not severe enough immediately to discourage the practice. For instance, the danger of flood does not serve to keep flood plains free of urban development; some families resettle in the same house and property several occasions in their lifetime after being driven out by floods.

Land Slope

The influence of topography, especially the slope of the land, is generally recog-



Figure 6: The Bayside of San Mateo County. View looking south from San Bruno Mountain. From the left, center background the bay, marsh and mudflats, bayside plains, bay-side foothills and on the horizon, the mountains



Figure 7: The coastside of San Mateo County. From the bottom of the photo; the ocean and the beach; urbanization is spreading from the coastal terrace toward the coastal foothills. The mountains are on the horizon



Figure 8: Beach and coastal terrace

Figure 9: Coastal foothills with mountains in the background

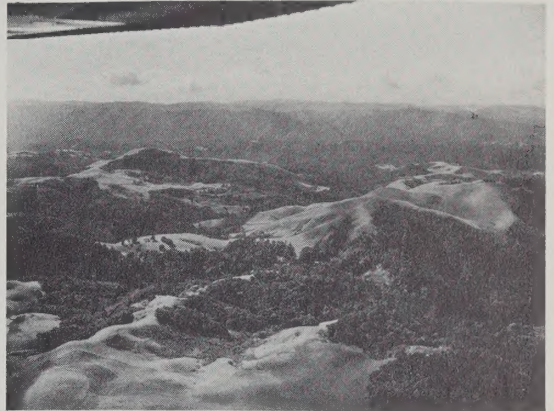


Figure 10: The mountains of San Mateo County

Figure 11: View looking into an upper valley

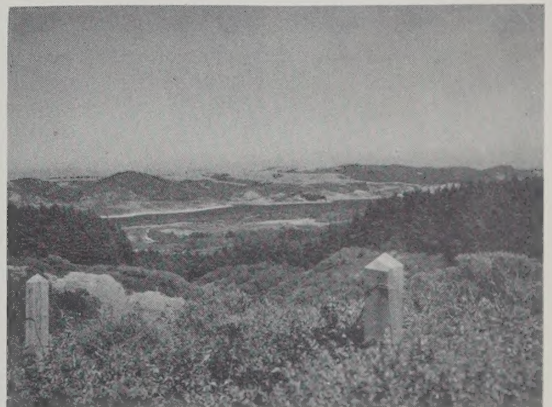


Figure 12: Bayside foothills



Figure 13: Looking from bayside foothills toward the urbanized bayside plains

Figure 14: Bayside marsh and mudflats



Figure 15: Man-made features become predominant over natural features of soil, topography and plant cover

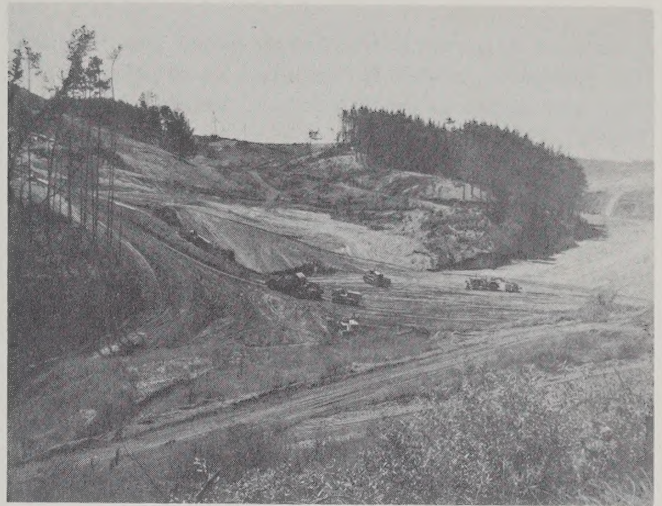


Figure 16: The reshaping of county foothills for housing sites

Figure 17: Hydraulic fill operation moving bay bottom to fill in marshlands



nized as a determinant of development possibilities for the site (Figure 18 and 19). Flat ground is usable for intensive activities; gentle slopes are suitable for movement and informal activities; and steep land is difficult to use or travel over (Figure 20).¹⁰

Most major industrial, commercial, educational and transportation facilities need reasonably level land, in order to keep grading cost at a minimum and to provide enough space for large structures and parking areas. Agriculture, if it follows land capability and proper erosion control, can use a variety of slopes; relatively flat land for irrigated crops, and steeper slopes for dry farming. The residential area, which is the major use of urban land, will utilize a variety of sites, but development costs rise with steepness of slope. There is a tendency to build low density residential areas on more steeply sloping land, thereby frequently utilizing sites of fragile soils which creates hazardous situations of landsliding in addition to the common hazardous condition for automobile operation and storage. Recreational areas need both level sites and lands with a variety of natural features.

Greater difficulty in building occurs with steepening slope. Steep land is often located on hard rock upthrust or a rocky ridge which is a poor site for excavation, for drilling water wells and for draining septic tanks. Steep slopes usually have shallow top soils and rocks close to the surface so that soil erosion, rock creep and landsliding are frequent problems. Plant cultivation is restricted by the shallow soil which provides only minimum moisture storage, dries quickly, limits root penetration and offers shallow root protection from heat and cold. Construction costs are increased because of the difficulty in excavation, and the need for installing retaining walls to hold buildable sites in place. These reasons make steeper lands economically unsuitable for any sort of mass or large scale building (Figure 21).

The expansion of an urban area usually tends to by-pass excessive sloping areas since it is not desirable to undergo the expense and inconvenience of building and living on steeper slopes. The development of steeply sloping land depends upon the amount of buildable land available elsewhere.

Slope Categories

The slope categories indicated on Plate VI were sketched from a quick review of topographic maps.

Slope may be expressed either in terms of degrees or as percentages. The slope map of this report uses percentage of slope. A 5% slope is one that changes five feet vertically for every hundred feet horizontally.

The slope categories given on Plate VI are interpreted as follows:

- 0-5% : This is the almost level area of the county which, in terms of land slope, is suitable for nearly all types of urban and agricultural uses. Some of this land is undevelopable because of poor drainage characteristics or because it is subject to flooding. Approximately 15% of the county is in this category.
- 5-15% : This moderately sloping land is usually too steep for airports or for heavy industrial activities which process large amounts of bulk materials by railroad and water shipping lines. Irrigated cropland is somewhat restricted, although dry farm activities and the safe

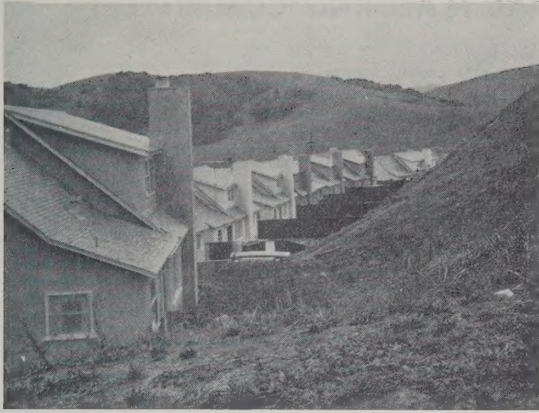


Figure 18: Backyard activities are limited by land slope

Figure 19: Man-made structures adjusted to steep slope



Figure 20: Devils slide area, showing trace of abandoned Ocean Shore Railroad on face of slope

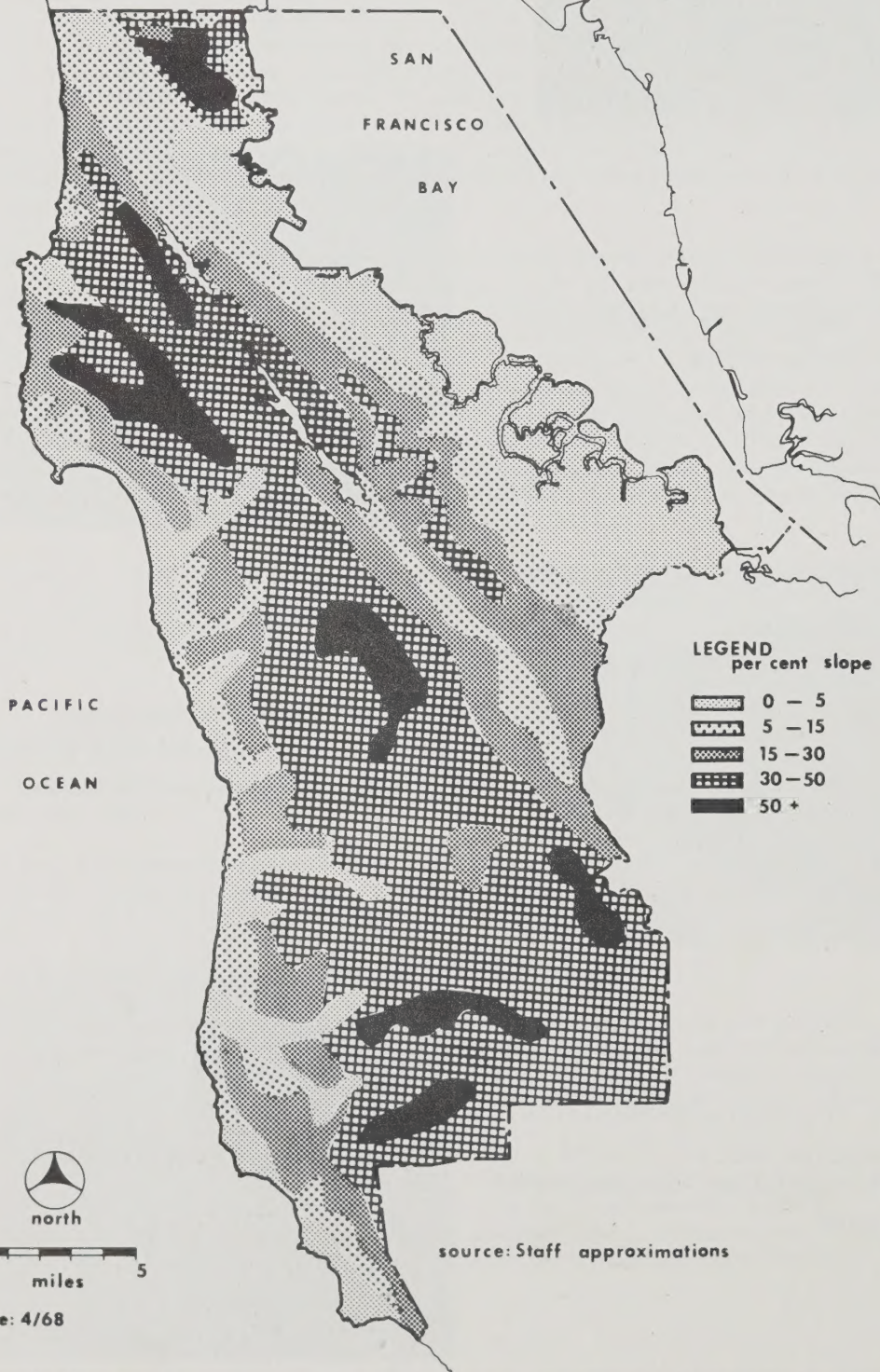
Figure 21: A hillside subdivision in which density and structural coverage are reduced as compared to flat terrain



SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

PLATE VI

Generalized Land Slope



operation of farm machinery can still occur on slopes in the upper range of this category. This slope of land usually provides good drainage and a varied, interesting setting for residential uses although construction of row housing and low-rise apartments will be adversely affected. About 15% of the county is in this category.

15-30% : These slopes are generally too steep for cultivated croplands due to problems of erosion and irrigation, although a slope of up to 20% is considered economical and practical for cultivation of artichokes and brussels sprouts.¹¹ Large tracts for light industrial activities are somewhat limited due to excessive site development cost. Detached houses, high-rise apartments, institutional complexes and intensive recreational uses will be moderately affected. Approximately 30% of the county is in this category.

30-50% : Slopes in this category can be carefully planned to be used for high-rise apartments, cluster and large-lot residences. In all cases, the over-all density of the developments must be low or else grading for roads, parking lots and playfields will be excessive. Although a particular use, such as a high-rise apartment, can be fitted easily into a site, the surrounding terrain must also accommodate a major arterial street to reach the building. Slopes in this category may also be used for low intensity recreational activities and summer resorts; and for forest and grazing lands. About 30% of the county is in this category.

50%

and up : These slopes are best suited for wildlife, forestry, and limited grazing. Road cut can cause problems if good conservation practices are not followed. T.V. towers, water tanks and reservoirs are frequently located on these slopes. About 10% of the county is in this category.

Drainage and Flooding

As urbanization spreads in San Mateo County, areas which were originally bypassed due to flooding hazards will become more attractive for development.

The streams of the county, although not of great length, originate in areas of high rainfall in the upper elevations of the Coastal Mountain Range. The volume of water carried in streams varies greatly throughout the year, in many instances peak annual flows occur in the several days of winter rainfall and the streams remain dry for the rest of the year.

Factors Which Affect Drainage Characteristics

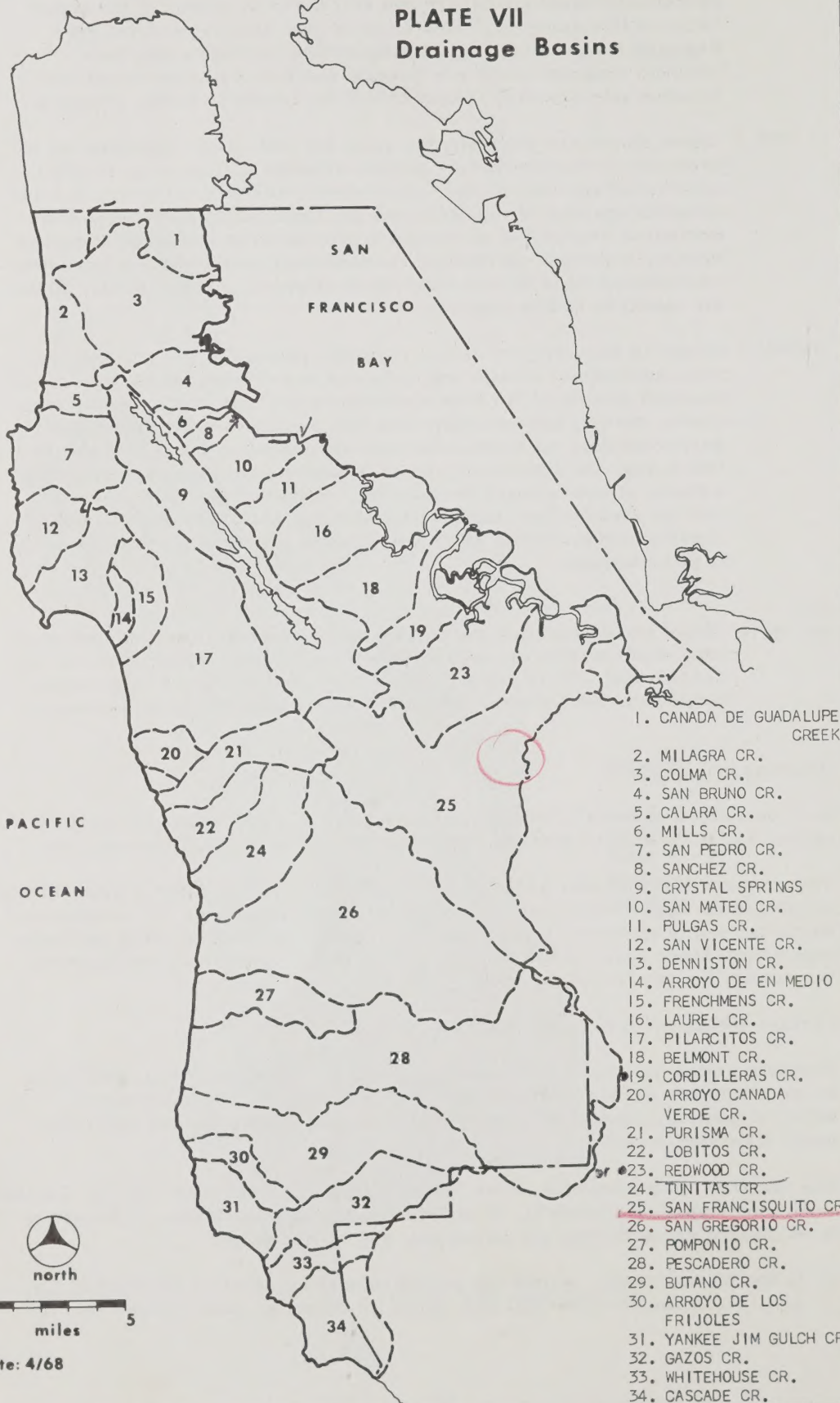
Drainage basins have been delineated on Plate VII. Rain which falls into these areas will follow predictable patterns. These basins, or watershed areas, utilize a natural system of ever growing tributaries to establish an underlying order for water runoff.

The drainage characteristics of San Mateo County are conditioned by: 1) Climatic conditions (especially rainfall), 2) soil conditions, 3) plant cover, 4) the extent to which land use activities are developed, and 5) land slope.

1) In San Mateo County, sources of precipitation may occur in the form of fog, dew, occasionally snow, hail and, more importantly, rain. Obviously, the

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PLATE VII Drainage Basins



0 5
miles
date: 4/68

rate of rainfall plays a large role in influencing amounts of runoff.

- 2) Dry soil absorbs and holds water. When the water content reaches a certain point, surplus water will penetrate by gravity - infiltrate - to underground strata of soil, gravel or porous rock where it may be stored as ground water. When the rate of precipitation is greater than the rate of absorption and infiltration, surface runoff occurs and water drains over the surface of the ground directly into creeks, rivers, lakes and oceans.¹²

Shallow soils overlying bedrock or hardpan have a limited capacity to absorb water. If the area is flat, ponding may occur and, if the area is steep, eroding of the small amount of shallow topsoil is likely. High water tables severely limit infiltration, restricts the use of septic tanks and present dangers for ground water pollution. Soils with poor permeability may create excessive surface runoff, enhancing erosion and restricting subsurface transfer of water.

- 3) Plants reduce erosion and flood peaks through several processes: a) the above-ground portions of the plants absorb the energy of the falling raindrops before they hit the ground thereby preventing splash erosion that physically splashes soil down slope, destroys the crumb structure of the soil, and seals the soil surface, b) this process of rainfall interception utilizes about 10% of the annual rainfall in wetting the brush and evaporates back into the air, c) another 10% of the annual rainfall collected by the plant top goes by stem flow to the ground at the base of the plant where a high infiltration rate exists due to the organic material in the soil and the soil-fauna activity under the plant, d) the plant twigs and parts which fall to the ground form barriers to water movement thereby reducing soil-carrying of the water and increase infiltration time, c) the plants, through transpiration, remove water from the soil mass thus providing space for water storage.¹³
- 4) Man's activities upset the natural drainage cycle. Undeveloped land that formerly would absorb a great deal of rainfall and provide for drainage through infiltration and natural drainage channels, has been changed into farm or urban sites. Please refer to Table 8 for a theoretical comparison of this affect.

TABLE: 8
Theoretical Storm Water Discharge by Types of Development*
(Area: one square mile)

Type of development	Description	Peak discharge (gallons/minute)
Wooded -----	Normal forest growth	30,000
Rural -----	50% forest; 50% farm	50,000
Suburban -----	40% wooded; 40% lawn and garden; 20% roof and pavement	140,000
Urban -----	50% lawn and garden 50% roof and pavement	360,000

*Assumptions: No ponding; moderate surface slope (generally 3%)

Source: Planning Advisory Service Information Report No. 109, p. 3

- 5) The angle of slope influences the amount of water which will run off the land surface. Given the same rainfall on level land, and on steeply sloping land, a higher percentage of the rainfall will run off the steeply sloping land. Moreover, the velocity at which the water flows is greater from steeply sloping lands than from level areas, so the fast-flowing water may cause more land erosion downhill from the steep lands than from gently sloping lands.

Problem Areas in San Mateo County

Flooding is a recurring problem in several of the watersheds of the county. (See Plate VIII) In the past, flood damage has been mainly confined to utilities, roads and agricultural lands; however, future urbanization is anticipated in many of the areas subject to damage from floods. Since 1951, the gauging station on Pescadero Creek has recorded six floods of major importance. The U.S. Corps of Engineers made a survey in the coastal area of the county after the flood of 1955 and estimated the total damage in the Pescadero, San Gregorio, Tunitas and Pilarcitos Creek watershed at \$485,000.¹⁴

In December of 1955, all small streams discharging into San Francisco Bay along the east side of San Mateo County overflowed their banks, causing inundation of residential and agricultural areas. The flood conditions created by heavy rains were aggravated by high tides which prevailed immediately after the main flood period.¹⁵ Over the past thirty years, storm and flood runoff has increased at a rapid rate in the urbanizing portion of San Mateo County.¹⁶ Urbanization has replaced water absorbing native plant growth with streets, driveways and rooftops of residences and more dramatically, commercial and industrial activities have covered hundreds of acres with the impermeable surface of parking lots. Such a change in drainage basin surface features serves to increase the rate and volume of runoff in addition to adding dust, detergents, oil, chemicals and other contaminants to the draining water.

A listing of urban places with flood problems in San Mateo County was prepared in June, 1967, by the Corps of Engineers, U.S. Army (see Table 9)¹⁷. Their report states in part that:

"The purpose of this list is to alert all Federal, State and local agencies to the flood problem in the urban places throughout the Nation and to inform them of the source of more information and assistance. It comprises all incorporated and unincorporated places having 2,500 inhabitants or more in 1960 and those towns, townships, and counties classified as urban in the 1960 Census of Population.

"The list contains information about the flood problems, studies made, protection works, maps, flood warning systems and sources of other data. With regard to protection works, it should be noted that seldom do they provide complete protection. Only those places protected against the Standard Project Flood are essentially free from flooding. In many places, flood protection works reduce damages on only one of the streams affecting the community. In other instances a dam upstream only provides partial protection because of tributary inflow below it.

"Maps are considered adequate only where their scales are 1" = 2000' or larger. The flood warning column received a Yes if the Weather Bureau considered the existing system adequate.

"The office shown as the information source will either supply information needed or refer users to proper agencies who have more complete information. Additional copies of this list may also be obtained from these sources.

"This list was prepared by the Corps of Engineers, U.S. Army, with the assistance of the Soil Conservation Service, Department of Agriculture; Geological Survey and Bureau of Reclamation, Department of Interior; Weather Bureau and Coast and Geodetic Survey of the Environmental Science Services Administration, Department of Commerce. In some instances the State of California provided information."

SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

PLATE VIII
Areas of Historical or
Potential Flooding

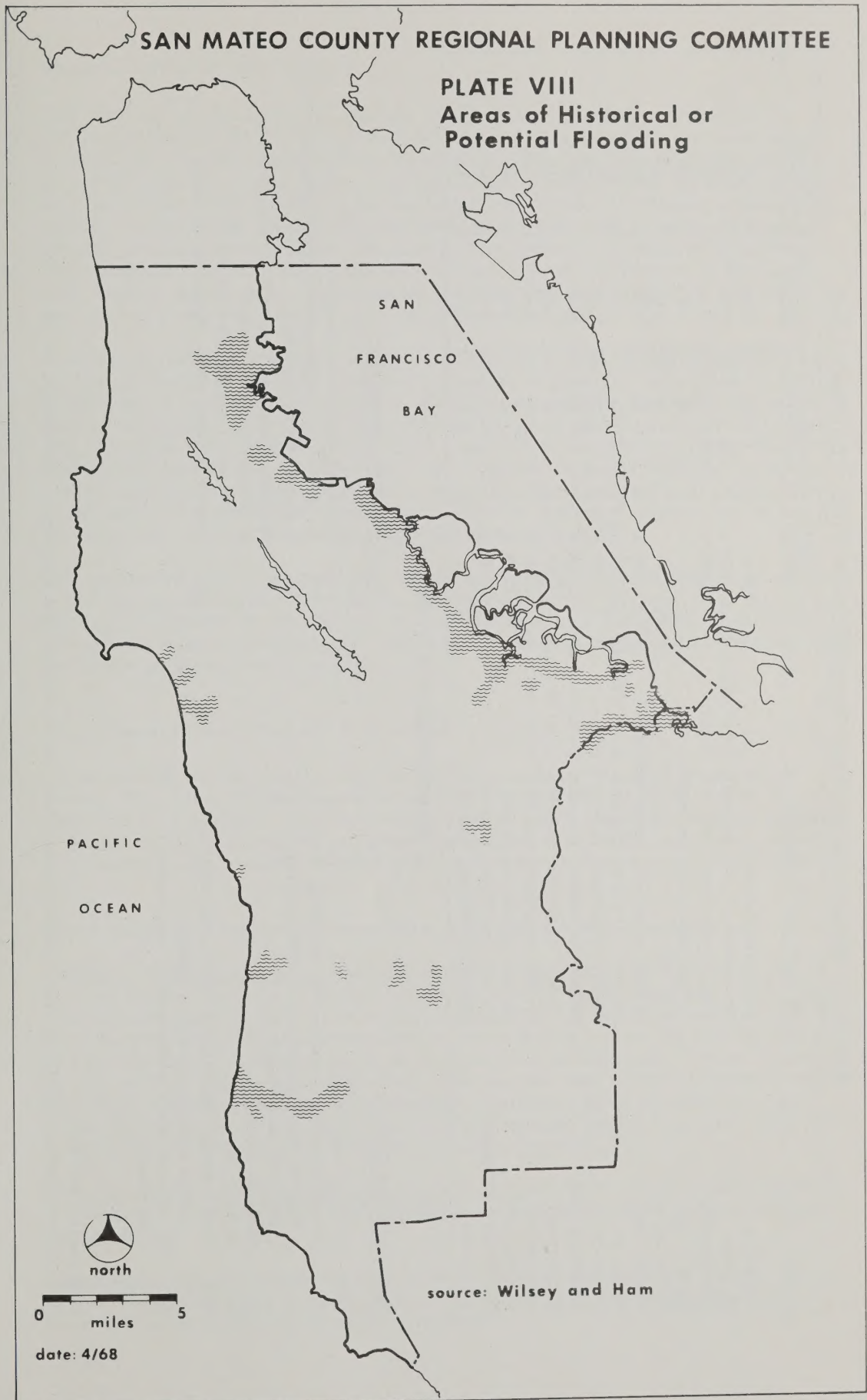


TABLE: 9 URBAN PLACES IN SAN MATEO COUNTY WITH FLOOD PROBLEMS

Place	Type of Flood Problem	Status of Flood			Flood Warning
		Studies	Protection	Maps	
Atherton	Stream overflow	L a	L e 2	Yes	No
Belmont	Stream overflow, coastal, local drainage	CSR a	CE e 2	Yes	No
Burlingame	Stream overflow, coastal, local	CSR c	CE e 2	Yes	No
Daly City	Stream overflow, coastal	--	2	Yes	No
Hillsborough	Coastal	--	2	Yes	No
Menlo Park	Stream overflow, local drainage	CSR a	2	Yes	No
Millbrae	Stream overflow, coastal, local drainage	CSR c	2	Yes	No
Pacifica	Stream overflow, local drainage	CSR b	2	Yes	No
Redwood City	Stream overflow, coastal, local drainage	CSR c	2	Yes	No
San Bruno	Stream overflow, coastal, local drainage	CSR c	2	Yes	No
San Carlos	Stream overflow, coastal, local drainage	CSR d	2	Yes	Yes
San Mateo	Stream overflow, coastal	CSR a	2	Yes	No
South San Francisco	Stream overflow, coastal	CSR c	2	Yes	No
Woodside	Stream overflow, coastal	--	2	Yes	No

EXPLANATION OF SYMBOLS

Status of Flood Studies

- CSR Corps survey report
 L Locally accomplished survey including flood hazard reports developed with Federal financial assistance
 a Study complete
 b Study active
 c Corps study authorized or SCS study application received, neither funded
 d No current study authorized or application received

Status of Flood Protection

- CE Corps of Engineers project
 L Locally constructed project (providing significant degree of protection)
 e Project found economically or engineering unfeasible; date (year)
 1 Flood plain regulation adopted
 2 Status of flood plain regulation unknown

Information Source:

U. S. Army Engineer District, San Francisco, 100 McAllister Street, San Francisco, California 94102

Flooding and the Public Interest

The planning and financing of drainage and flood control projects encounters a number of difficulties. Urban growth follows a complex pattern which crosses political and natural drainage area boundaries. The problems of floods are no longer the concern of one agency or of one level of government. Drainage follows the natural gravitational forces but the boundaries of new developing subdivisions seldom coincide with natural drainage area boundaries, and in some instances, grading procedures will change the natural flow pattern. Disregard of drainage characteristics or poor standards for drainage systems can result in flooding with the first heavy rain. The capacity of better drainage facilities, generally built to meet only immediate needs, is quickly outmoded.

Drainage facilities comprise a utility-type service to real property that does not lend itself easily to special assessment financing because the allocation of benefit is difficult or even controversial. In partly developed hillside areas, the property owners in the upper portions of the drainage area are not inconvenienced by heavy and prolonged rain. Those at mid-slope may have occasional minor flooding while those at the bottom are subject to severe damage from heavy rainfall. It is no simple matter to convince the property owners in the upper portions of the slope of the need for a storm drainage system, especially when it comes time to pay for storm drains visually benefiting properties downstream.¹⁸

The remaining part of the problem related to flooding is in establishing an effective working relationship between the generalist planner, the engineer, the economist, the public health official, the private developer and other specialists whose knowledge and training are required for adequate appraisal of developmental problems in flood-prone areas.

Flood Damage Correction and Prevention

Flood control and prevention projects seldom provide protection for all conditions. Due to the substantial cost of projects, only a degree of protection is built into each system. The maximum runoff probable within an assumed period of time, such as fifty years, is selected to provide a basis for calculating drainage facility needs. Runoff exceeding this selected magnitude may result in flooding.

Flood damage corrective activities may utilize the following techniques:¹⁹

Dams, reservoirs and levees may be constructed to reduce the volume of runoff at flood stage. These corrective measures are extremely costly and involve huge expenditures yet still do not accomplish the objective of totally preventing loss of life and property. These are two factors which tend to reduce the effectiveness of these methods. The first is due to the general high unit cost of water storage in reservoirs. The second factor deals with the fact that these correction methods are most effective when located immediately upstream from the area protected. On the coastal side of the county, the distance between many previously proposed reservoir sites and the protected site is relatively great.

Channel improvements and watershed treatments are generally the most economical means of providing improvements for flood control but have rather limited effectiveness.

Temporary measures would include flood proofing buildings, temporary evacuation and timely warning to endangered areas. However, annual floods would constitute a recurring and disruptive problem.

Preventive measures seeking methods of minimizing the effect of flooding to the individual exposed may include the following techniques:

Flood insurance, although offering some protection to the individual policy holder, does not solve the problem.

Urban redevelopment, incorporating tax adjustments policies, acquisition of land and a new design approach seeking to reduce urban improvements in flood areas may be formulated into governmental policies prohibiting the reconstruction of streets, utilities and other facilities needed for intensive urban development. Land use in flood plains may be redirected towards agriculture, parking lots, parks and other open space activities.

Policies of private lending institutions and of public agencies, principally the Federal Housing Administration and Veterans Administration, requiring the elimination of flood hazards as a prerequisite to secure loans, have been very effective in reducing flooding damage.

Flood plain regulations enacted in Zoning Ordinance, Subdivision Regulations, Building Codes and Health Regulations can be very effective in directing urban growth away from hazardous areas. These policies are of value too, in establishing areas of responsibility for water runoff.

SOILS

Soil provides the floor and foundation for all of man's activities. It is distributed in an organized arrangement according to the influential combinations of five factors: 1) climate, 2) vegetation and associated animals, 3) earthy parent materials, 4) relief, and 5) age of land form.²⁰ Through eons of geological time the forces of rainfall splash erosion, runoff, glaciation, freezing, thawing, ground upthrusting, and wind have shaped land forms and soil conditions. All soil was initially rock which has been attacked by the physical and chemical forces of the atmosphere and is broken down ever smaller into rock fragments. Vegetation, animals and micro-organisms react on the mineral content of the rock fragments, reducing them and producing organic residues and other complex compounds.

Everything installed above ground gains support either on or in the soil. Slippage, depth of rock, depth to water table, bearing strength, frost heave, flooding hazards, corrosion potential, erosion hazard, plant material cover, depth of topsoil, and percolation rate are a few of the many soil conditions that affect the design, construction and cost of human structure. Generally, human activities occur above ground level, however, there are some instances when underground or multi-level structures become desirable. Ground characteristics for excavation and foundation then become even more influential.

Many of the townsites in the United States were selected at a time when transportation was largely by water, and sites near oceans, lakes, or rivers were chosen. In such places the patterns of geological formation, relief, previous erosion effects and sedimentation have formulated complex soil patterns. The land mass upon which urban development has occurred in San Mateo County is typical of these townsites. Since much of this urbanization has occurred without benefit of soil suitability studies, an occasional result has been wasted labor, wasted investment, and personal hardship to individuals who try to use sites that cannot be made suitable with only moderate cost or changes in land form. Urban problems related to soil conditions in these areas will probably recur continually, as the cost of more compatible redevelopment appears prohibitive.

Ideally, sites for agricultural, industrial, residential, commercial and intensive recreational activities are characterized by deep, well-drained, permeable soils on gentle slopes. In such conditions, problems related to site development are usually at a minimum so site utilization cost can be kept down without incurring hazards to life and property. Many of the best sites in San Mateo County have already been occupied by urbanization and there is a need for careful evaluation of the remaining open lands.

Certain areas of San Mateo County are highly susceptible to sheet and gully erosion, land slippage, subsidence, sedimentation, flooding and water pollution dangers. Some of the high mountain and upper valley areas of the county have climates - fog free with a variety in temperatures - which are favorable for urban development but their very frail soil and underlying sedimentary rock create development problems. The Purisima, Monterey and Mindego formations of fine grained sedimentary materials in the coastal regions are considered rather unstable for intensive land uses and tend to erode, slide and contribute large sediment loads onto drainage ways, roads, streams and reservoirs. In addition to these problems, flood problems exist in nearly all of San Gregorio, Whitehouse and Pomponio Creeks. Equally divided between frail and better lands are Gazos, Butano, Pescadero, Tunitas, Lobitos, Purisima and Arroyo Leon Creek watersheds.²¹

The recognition that a particular soil is prone to fail in one area or another, or prone to slide under certain conditions can be an invaluable aid in long-range planning and in the evaluation of all potential urban sites. If the natural conditions are properly analyzed, potential reconstruction cost can be avoided. Substantial evidence exists to conclude that certain slope and soil characteristics limit, increase cost of development or create hazardous circumstances for the various activities of man. Some of the more significant influences of natural soil conditions are dealt with in the following paragraphs.

High Water Table:

- 1) Limits rooting zone (depth) of plants.
- 2) Prevents absorption of effluent in septic tank filter fields.
- 3) Increased construction cost due to need for waterproof basements and installing sump pumps; additional hazard of water seepage damage to underground structures.
- 4) Water saturated soils create poor drainage conditions for surface water.
- 5) Increases danger of polluting underground water supply.

Stones and Boulders in High Concentration:

- 1) Increase excavation and general construction cost.
- 2) Limits surface uses for agriculture, golf courses and intensive recreation sites.

Bedrock and Hardpan

- 1) Shallow overlying soil has limited capacity to absorb water. It severely limits sewage disposal systems and presents sanitation problems when these facilities are installed over bedrock or hardpan soil layers.
- 2) Increases cost of excavation for foundations and pipelines.
- 3) Shallow overlying soil has only a limited capacity for water storage so that lawns, gardens, crops and trees quickly show effects of drought if growing on these soils.
- 4) Erosion damage is intensified due to existing shallowness of topsoil.
- 5) Increased danger of landslides due to lubrication effect of underground water on top surface of tilted bedrock.
- 6) Limits depth of rooting thereby increasing wind throw damage to trees.

Bearing Capacity

The poor bearing capacity of some soils does not provide support for heavy loads and are subject to slippage. Soil support failures can cause break up in roads and building foundations. Frequently, soil strength will undergo changes with shifting conditions of wetness or dryness.

Soil Permeability:

- 1) Slow percolation rates may preclude the utilization of septic tanks and require public sanitary sewer hookups. In some instances, the limitations of a slow percolation rate may be compensated for by increasing the size of the sewage filter field. This factor is frequently a basis for requiring a two, five or even a ten acre lot size.
- 2) Soils with low permeability may create excessive precipitation runoff which results in flash flooding of lower areas.

Although civil engineers and soil scientists have worked with soil data since

about 1925, it has only been during this recent time of rapid growth on the metropolitan fringe that urban planners and developers have started utilizing soil information. At present, there is a general awareness that information about soils can aid growing cities to avoid or to properly plan for areas where construction failures will probably occur and that a savings in design and construction cost can be accrued. Houses and roads can be built on soils that are poorly suited for that use, but only with costly designs. Experiences of construction failures on poor sites have unfortunately, often led to over-design and extra cost on sites that are well suited for development.

For regional planning purposes, generalized soil maps covering the entire county and showing different association of major soils may be used. Although soil scientists do not suggest what the use of any soil should be, they can predict what the soil behavior will be under specified uses. The planner can thus rate the soils according to their suitability for a particular use. The general soil map gives planning groups valuable clues to the location of broad areas suitable for various uses. More precise site selection can be done with the use of more detailed soil maps.²²

Predictions can be made about certain areas of the county as based on soil knowledge and on generalized soil maps. The following discussion is based on a report prepared for generalized planning purposes by the Soil Conservation Service.²³

Erosion Hazards

Plate IX is an analysis of erosion hazards. Although San Mateo County's erosion problems are now largely under control, erosion still has the potentiality of becoming a major problem. This danger is most prevalent in areas where contractors scalp the earth's surface of all vegetation and leave the soil bare for long periods. As building occurs, increasing soil areas are covered by impervious materials which tend to divert runoff from some areas and built it up to destructive volumes in the unprotected areas.

Concentrated runoff carries away topsoil, cuts gullies, washes out roads, damages newly dug or filled areas. The sediment clogs ditches, culverts and fills lakes. Local planning activities should include plans for controlling erosion, controlling sediment and the disposing of water for each watershed.

Erosion control plans should be based on the probable hazards which will be present when the watershed is fully developed. Planning activities of concern include the review of development schemes for: 1) the location of lots, houses and roads in relation to natural drainage channels, 2) adequate controls of sediment and water, 3) size and location of waterways, storm sewers and diversion terraces, and 4) the proper application of vegetation to control erosion.

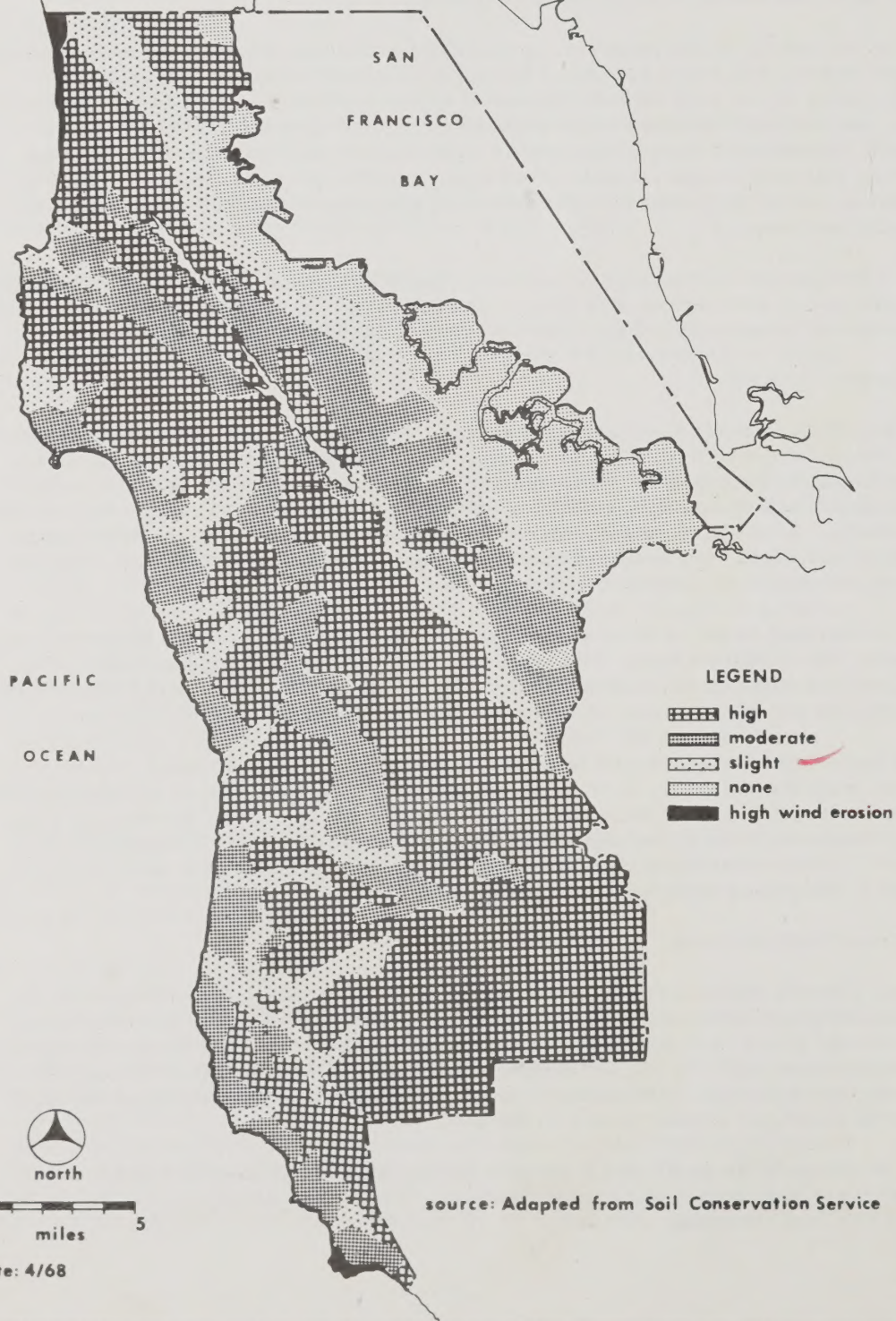
Shrink-Swell Behavior

Areas where shrink-swell behavior has been observed are indicated on Plate X. The shrinking and swelling of soil material, critical in selecting sites for structures and roads, are qualities that are not easily detected. Shrink-swell behavior denotes that quality of the soil that determines its volume change with variations in moisture content. The volume change is influenced by the amount of moisture and the kind and amount of clay in the soil.

A variation in the usual shrink-swell behavior may sometimes be found in soils which are high in clay and organic matter. They shrink greatly on drying but do not swell on rewetting.

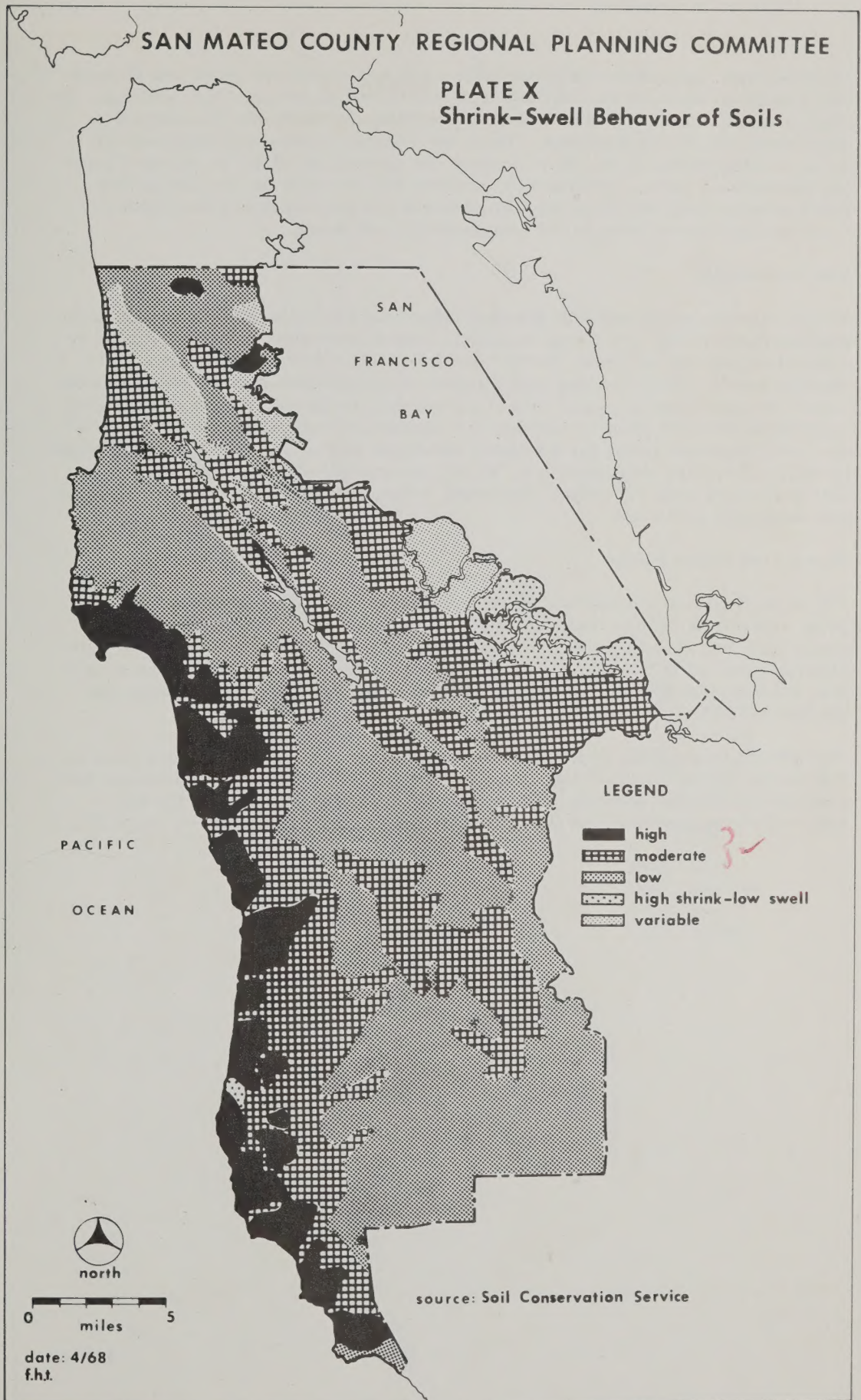
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PLATE IX
Erosion Hazard



SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

PLATE X
Shrink-Swell Behavior of Soils



On level land, soils that contain unstable clays and shrink and swell can be used for structures provided the foundation is sturdy enough to resist soil shifting. On sloping lands, unstable soils of this kind may slip downhill, thereby damaging structures, roads and pipelines. Thus, the general influence of shrink-swell soils to urbanization is that they increase the probability of the break up of building foundations, dams, pipeline and roadbeds due to expanding or contracting movements of soil, unless protective construction processes are incorporated. Construction cost in these areas are generally increased.

Soil Corrosivity

Unless closely correlated with physical, chemical and biological characteristics and qualities of soil, structural materials buried underground, such as metal or concrete pipe, will corrode. Some materials will corrode in some soils more rapidly than in others, so that costly replacement operations may be necessitated before the calculated economic life of a material is achieved. To be meaningful, corrosivity must be given in relation to a specific structural material. Plate XI is a soil limitation rating for untreated steel pipe buried underground in San Mateo County. The three classifications, slight, moderate and severe, are based on soil properties such as texture, drainage, permeability, total acidity and electrical resistivity of the soil.

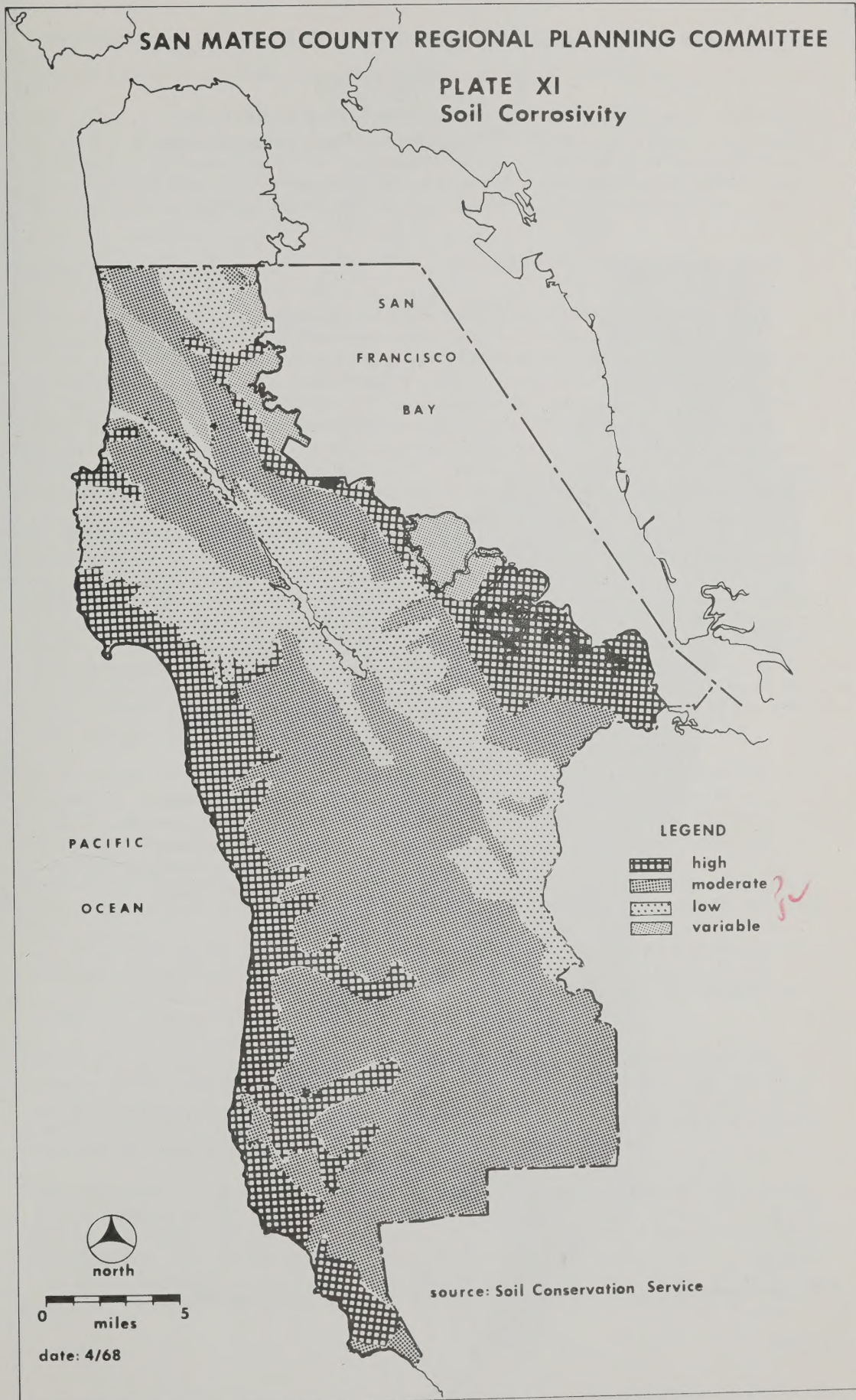
Septic Tank Filter Fields

For urban development that occurs without a hookup to a public sewerage disposal system, the septic tank filter field is the most important aspect of the septic tank soil absorption system for on-site sewage disposal. The septic tank disposal process is dependent upon a sub-surface tile system laid in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil.

The effectiveness of the septic tank disposal process is based on factors such as soil depth, slope, permeability, percolation rate, water table, soil drainage and overflow or flooding hazards. These factors, along with other criteria and standards have been used for the soil limitation ratings illustrated on Plate XII.

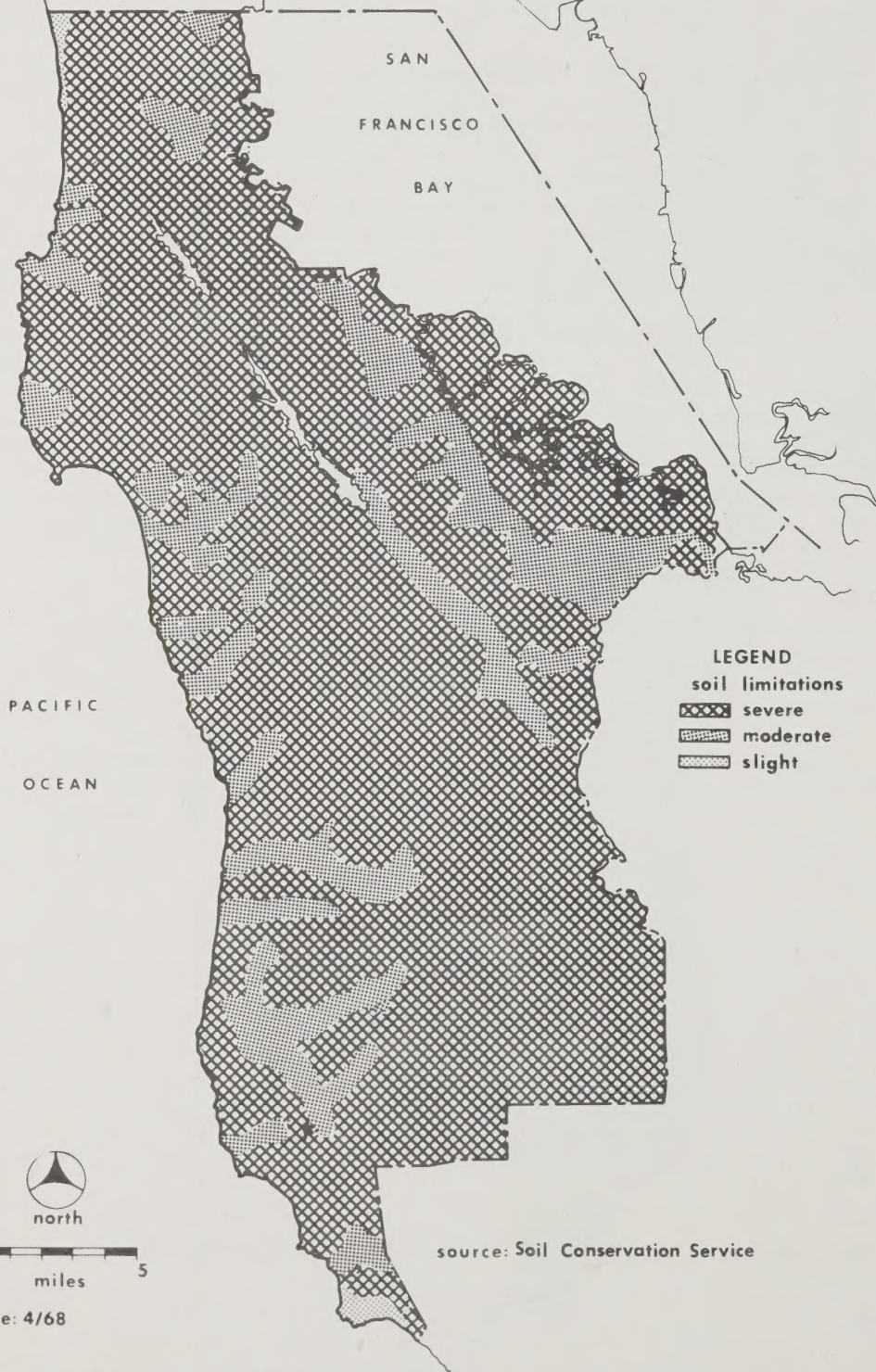
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PLATE XI
Soil Corrosivity



SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

PLATE XII
Suitability of Soils for
Septic Tank Filter Fields



GEOLOGICAL HAZARDS: EARTHQUAKES AND LANDSLIDES

The purpose of this section is to draw attention to large county features pertinent to local problems, not to replace detailed site investigations made by engineering geologists. All planning decisions must be based on factual knowledge, both general knowledge, as reviewed here, and specific site information, which can come only from detailed inspection of each location under consideration.

EARTHQUAKES

The major seismic hazard region of the United States appears to be centered through California and Alaska which have more earthquakes and much more damage than all the other states together. There were 10,126 earthquakes with a Richter magnitude over 3 in Southern California alone in the period from 1934 to 1963. Based on past records, it is estimated that an earthquake of 8.5 intensity, like the 1906 San Francisco quake, may occur somewhere in California every 52 years. Earthquakes of 6.3 magnitude, like the one in Long Beach in 1933, can be expected every 7 years.²⁴ During the past 50 years, the state has experienced an average of one earthquake of destructive magnitude every year.²⁵

In the Bay Region, earthquakes of destructive magnitude can be expected to come primarily from movement along two major faults. The first is the Hayward Fault which is located eastward across the San Francisco Bay from San Mateo County and extends through the counties of Santa Clara, Alameda, Contra Costa, Solano and Napa. The other major fault is California's most spectacular and well-known fault, the San Andreas, which extends throughout the length of San Mateo County.²⁶ The San Andreas fault related earthquake of 1906 has become well-known due to its great Richter magnitude, 8.5, and the striking geological effect of the fault zone. It has continued to be of concern to San Mateo County because of the historic series of lesser quakes which have originated in the fault zone.²⁷

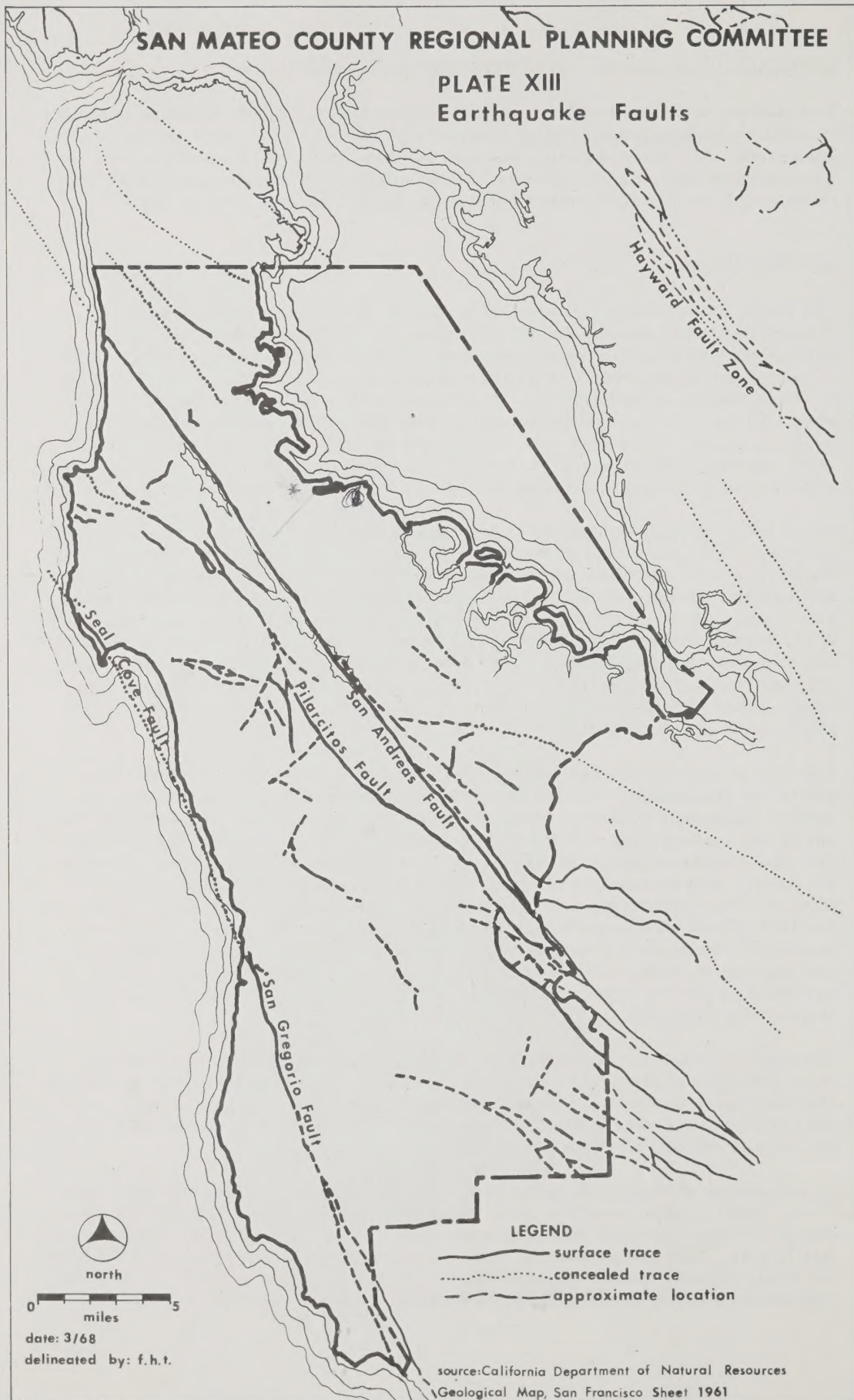
Although present knowledge about earthquakes does not support precise statements for predictions, enough information is available to shape prudent foresighted policies in regard to urban development. Man can not stop earthquakes, but he can learn to live with the problems they cause. A point of beginning for this policy is to recognize that there will be earthquakes in San Mateo County in the future, thus actions need to be focused on diminishing the potential destruction. Another underlying theory is that the earth's crust is very slowly changing and that ground strains build up. Earthquakes release this strain. The weak portions of the earth's crust are where earthquakes have happened in the past and thus can be expected in the future. Geological evidence indicates where earthquakes may be expected, but not when.²⁸ Faults in San Mateo County are indicated in Plate XIII.

Problems of urban development in areas of seismic activity concern analysis from a number of disciplines and interest: geology, soils engineering structural engineering, economics, esthetics and psychology. Thus policy decisions must not err in making sweeping statements without investigating the areas of concern for each discipline involved.²⁹

Investigations of past earthquakes have provided evidence to conclude that some areas within a quake zone are more stable than others. Some areas of the county can be developed without incurring more risk than is typical for the San Francisco Bay Region. The strong shaking action of earthquakes, whether near or far from the fault, depends mainly on the character of the underlying ground. Generally, only earthquakes of severe magnitude damage structures erected on solid rock.

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PLATE XIII
Earthquake Faults



Unless there are special hazards, such as fault movement under structures, or large permanent ground movement during earthquakes, earthquake proof engineered structures on firm soil can be expected to withstand severe earthquakes with only superficial damage.

Special Problem Areas

Whether or not a given area is dangerous depends on many factors. Certain areas of the county may be considered as high risk locations due to the character of the ground. Even small earthquakes may be expected to cause damage in the following high risk areas:³⁰

- 1) Narrow belts following fault zones including broken and weak ground.
- 2) Valleys or old lake bottom areas of weak structured alluvium soil deposits and badly broken rock frequently identified with landslides.
- 3) Coastal areas of beach sand and dunes.
- 4) Hillside lots especially if created by artificial fills with loose grading materials.
- 5) The surface of relatively old landslides.
- 6) Locations near the waterfront in areas of bay mud, clay and artificial fill may be considered hazardous due to the intensified damage occurring in like locations in the 1906 San Francisco earthquake.

Large, heavy structures on poor ground are particularly susceptible to settling and subsidence either at the time of shaking, or even long afterward, which may throw them off level, or warp the foundation. The sinking or sliding of the earth around these structures can depend on many factors including: the soil material, depth to bed rock, the nature of the soil layering, the degree of water saturation, the fluid pressure, nearness to slope, and the load added to the site by fill and buildings.

Competent engineers can design high-rise structures for high-risk areas which will not be irreparably damaged in case of a strong earthquake. However, there is still the probability that people will be injured and that there will be economic losses through damage and repair to non-structural property.³¹ Another significant earthquake hazard in the county at the present time is concerned with structural failure and falling debris, especially from false fronts and overhead cornices of buildings in older commercial districts that have not been designed or built to withstand quakes. Until 1920, the general building standards were low, regulations were few, sketchy and only perfunctorily enforced. Fortunately, many of these districts are being replaced with newer buildings for more beneficial economic activities.³²

Improvements in public building construction, especially schools, were encouraged by the Field Act of 1933, which was prompted by the Long Beach earthquake of that year. The act is concerned with the construction of public buildings, and places control within the jurisdiction of the state which requires an examination of the foundation bed of each school building before construction begins.

Other problems arising from the effects of earthquakes are concerned with probable destruction of water mains, sewer lines, gas lines and other utilities that are buried in the ground. These lines have ruptured in past quakes, especially in areas underlain by thick unconsolidated sediment. Massive destruction of these underground utilities introduce a danger of epidemic affecting those living in areas of high earthquake damage risk as well as those in more stable areas.³³

Conclusions

Possible conclusions to be drawn from this report on earthquake hazard are:

- 1) San Mateo County can anticipate earthquake damage in the future and should seek to reduce potential destruction.
- 2) Competent structural and soil engineering techniques can be utilized to build earthquake proof buildings at an increased construction cost.
- 3) Earthquakes present severe hazards which should be investigated by a multi-discipline team. The output of the study would be to map high-risk areas within the county and review possible restrictive effects to present and future public facilities.

LANDSLIDES

The great influx of people into the state and into the county within the last decades has intensified the rate at which urbanization is occupying relatively level land. As this flat land is used up, urban development will become more extensive in hilly and mountainous areas. Unfortunately, the sites of older landslides add character to an otherwise featureless landscape and frequently create dramatic sites for housing. Although the orderly arrangement of houses and streets may be suited to level areas, the orderly layout concept when carried to the hills upsets the delicate balance of the slopes and triggers landslides.³⁴ Unless hill-side development is carefully managed, damage to property, perhaps even loss of life, can be expected to occur due to an increased slide incidence on many of the fragile-soil hillsides of San Mateo County (Figures 22, 23). The incidence of landslides has a definite connection to the economic well-being of the county taxpayer. Even small slides which cause a backyard or a single house to slide create crushing financial losses to the landowners. A recent judgment against the County of Los Angeles, which found them to be a party to the reactivation of an ancient slide in Palos Verdes cost the county taxpayers \$5,360,000.³⁵

Landslide problem areas in San Mateo County include the Purisima, Monterey and Mindego formations which contain unstable marine sediments and lava materials that have been shattered by folding and faulting so that the group is relatively uncemented, unconsolidated and incompetent of resisting earthquake forces, running water, excessive pressure and undercutting by roads and other construction.³⁶ Plate XIV illustrates some of the known landslide areas.

Preventive measures for landslides usually begin by identifying potential landslide hazards. The stability of a hazardous slope may be increased merely by flattening the slope angle. More elaborate measures frequently include the construction of fill buttresses, walls, and the use of gabions and pilings. In some instances partial or complete removal of unstable material has been resorted to. Stability is also acquired by reducing ground water pressure in the unstable area.

Landsliding is part of a more general erosion process, called mass-wasting, which refers to the down-slope movement of earth materials. Mass-wasting may occur as a slow or a fast process.

- 1) "Creep" identifies earth materials with poorly defined bounds moving at imperceptible rates with a lower limit of about two inches per year. The process is related to slides in that creep prepares the slope for more rapid mass movement by: a) increasing permeability, b) reducing shear strength, c) oversteepening slope, and d) developing down-slope structure in soil and detritus.
- 2) Landslide identifies a discrete unit of earth material moving at a perceptible rate. Maximum velocities of around 125 miles per hour can occur for rock in free fall. Landslides transported on layers of compressed air have been demonstrated as physically and theoretically possible, which could serve to accelerate masses to speeds beyond the terminal velocity of free fall.³⁷

Landsliding is an important factor in shaping the earth's surface and has been active as long as there have been natural slopes. The force of gravity periodically pulls down masses of earth materials from exposed slopes created by geologic upthrust and wind and water erosion. The process produces much of the debris that is later carried away by streams and rivers to be deposited as sediments in basins and on ocean floors.



Figure 22: Street damage by the Vista Verde Way landslide

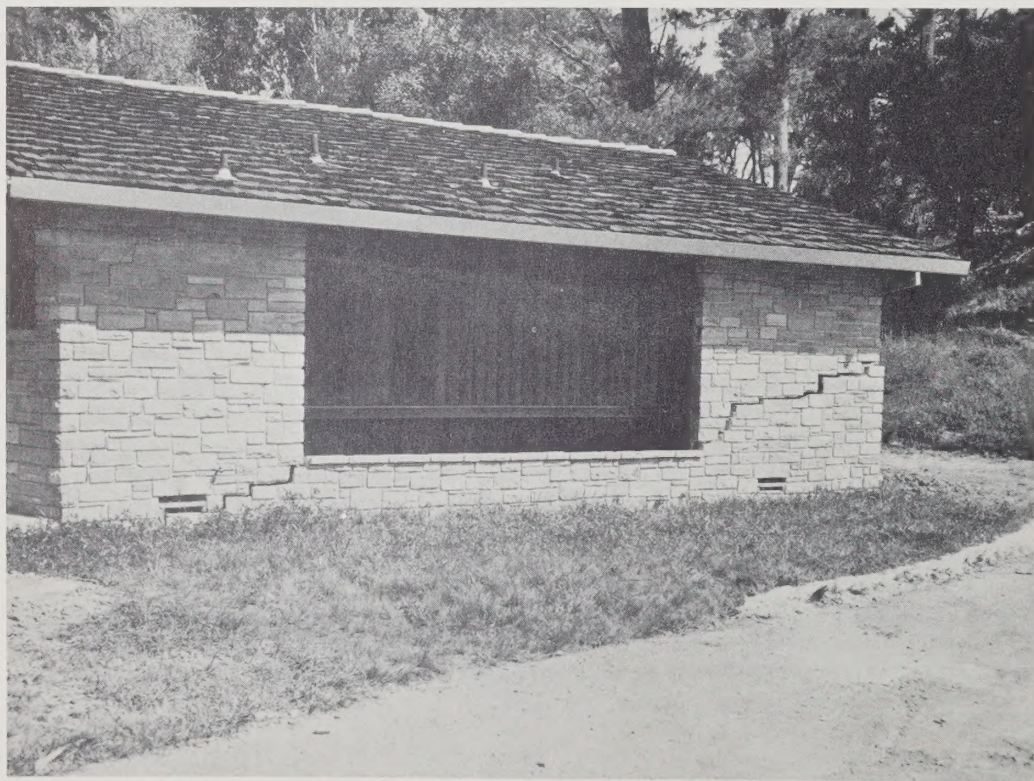
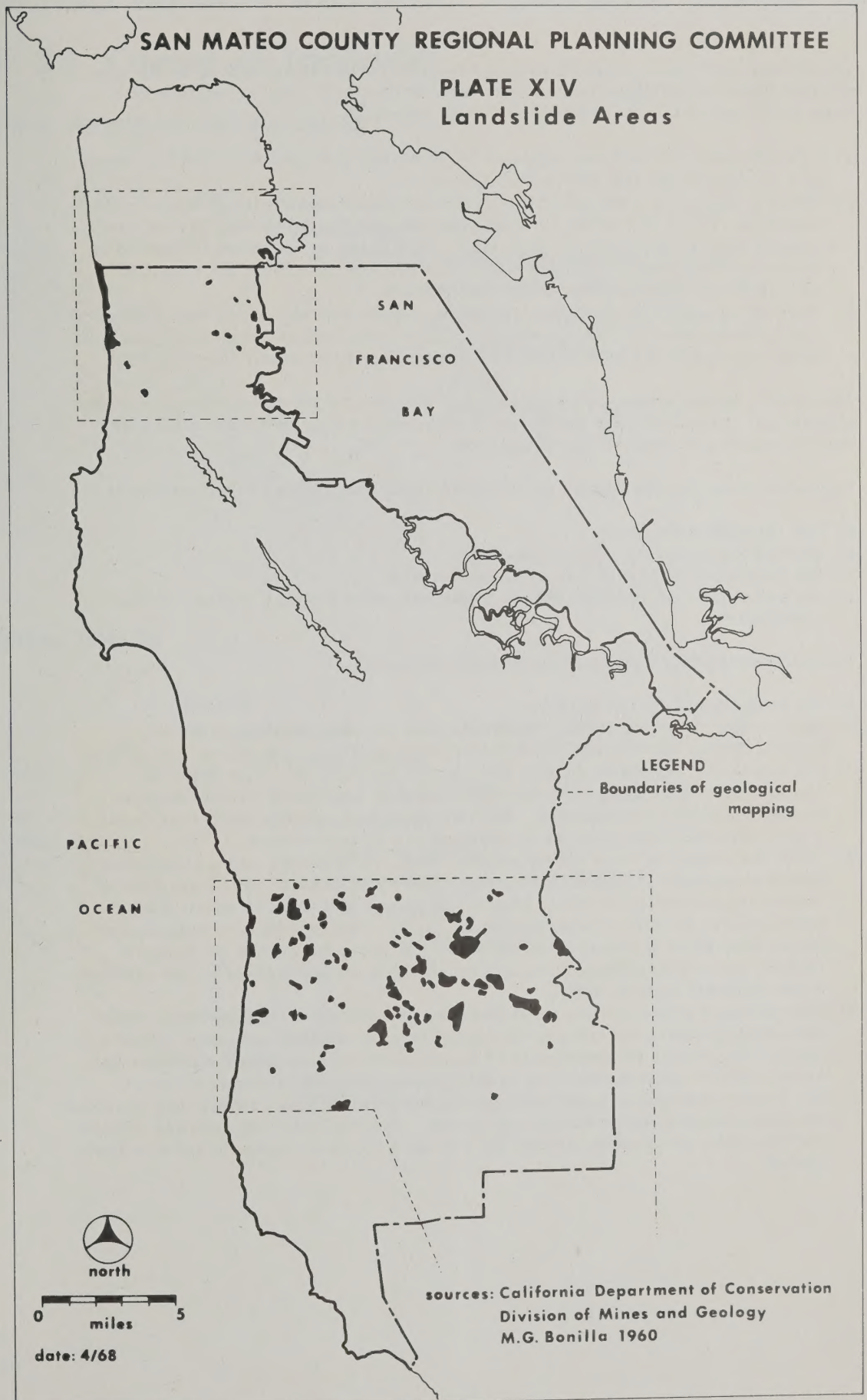


Figure 23: Structural damage caused by landslide

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PLATE XIV
Landslide Areas



Landslides have been categorized into principal divisions according to the type of slide movement and further broken down by the rock, soil or mixture of materials involved. There are three basic types.³⁸

- 1) "Falls" describe the free falling of earth material of any size that has stood in a vertical slope for even a short time.
- 2) "Flows" describe a deformed and displaced mass moving like a viscous fluid. There is no discrete slope or shear surface and the mass may have a water content ranging from dry to saturated. Mud flows are a common feature of the arid or semi-arid areas of California and are generally the result of canyon scour following torrential downpour.
- 3) "Slides" describe the movement of rock, debris and soil which takes place on one or more shear or slip surfaces. The affected mass consists of single to numerous segments bounded by slip surfaces and commonly move rapidly.

The causes of landslides may be separated into two major categories according to material characteristics and those of external forces, however, all factors may be working at once.³⁹ See Figure 24

Landslides may be contributed to by the inherent properties of the materials:

- a) low strength materials.
- b) minerals possessing perfect cleavage.
- c) the shrink-swell characters of the materials.
- d) the orientation of bedding planes, joints and other regular surface of the earth mass.

Landslides may be contributed to by external forces:

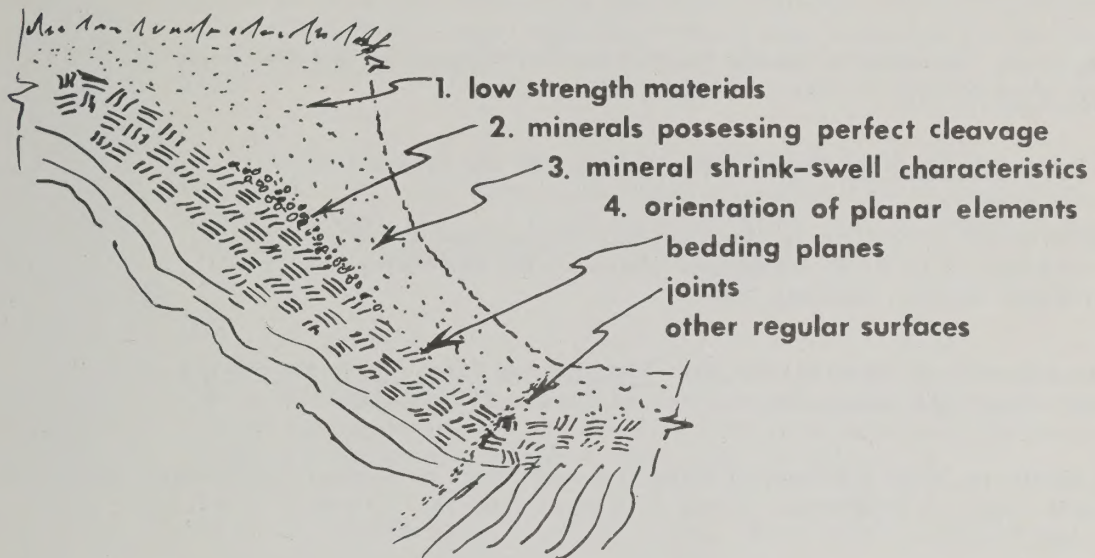
- a) the continuous force of gravity.
- b) the erosion of the supporting base of a slope by wind or running water, especially wave action which produces steep cliffs and recurring landslides.
- c) Landslides in San Mateo County are almost exclusively a winter month phenomenon correlating with the rainy season, especially during seasons of above-normal precipitation. Rainfall absorbed into the earth mass adds weight and may also serve as a lubricant for slide surfaces.
- d) Since the county is in an active seismic belt, earthquakes add a significant new dimension to landslide problems. The earthquake of 1906 triggered a number of landslides on steep slopes and in soft alluvium along stream courses over an area of approximately 13,000 square miles. Faulting can cause landslides in manners other than by shaking during the earthquake, such as by oversteeping slopes and by changing stress factors in low strength areas adjacent to fault zones.
- e) Man-induced slides are the most familiar and the most troublesome. Hill-side developments can trigger old landslides and initiate new ones. Man's desire for orderly arrangements of houses and streets nicely suited to flat areas doesn't necessarily work in hilly areas where it is easier to upset the delicate balance of earth materials. Houses and highway fill may overload the slope causing undue stress and slides. Surface watering, sewage effluent and changing community demand for ground water may serve to release landslides.

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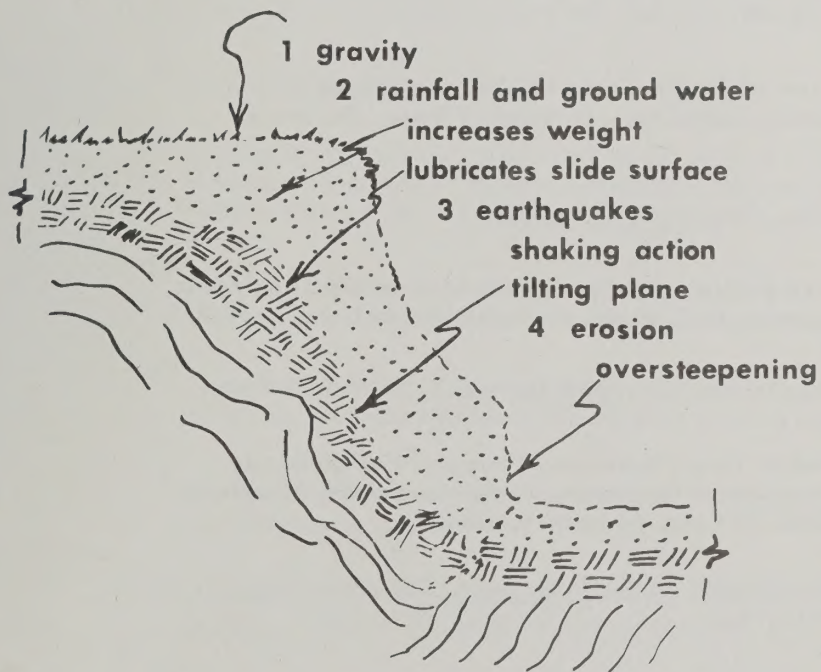
FIGURE 24 Causes of Landslides

For illustrative purposes only

INHERENT PROPERTIES OF MATERIALS



EXTERNAL FORCES



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chapter III

the minerals



MINERAL RESOURCES

The demands for mineral resources are rapidly growing as a result of increasing population and steadily rising standard of living; however, the chief demand is in connection with production for national defense. The most widespread use and greatest dissipation of non-renewable resources has occurred in the immense wars of this century and in the precarious periods of peace.

There are several fluctuating factors determining the economic value of a mineral resource; the cost of mining and processing, the cost of marketing, and the demand for the commodity. Since sociological, technological and economical factors can quickly change, the development of a resource which is unprofitable today may become the basis for a profitable enterprise in the future (and vice versa).

The distinctive characteristic of mineral economics which creates problems both in concepts of land utilization and execution of resource development, is that once a mineral resource is exhausted it can not be replaced. With the depletion of high-grade mineral deposits, it will be necessary to develop lower-grade deposits, particularly those that give promise of yielding more than one commodity. Since many mineral extraction activities are not compatible with, or are prohibited in the present urban setting, there is a pressing need to identify, hasten extraction or preserve resource sites which could be pre-empted by urbanization.⁴⁰

The principal commodities produced in San Mateo County have been cement, magnesium compounds, crushed stone (sandstone, limestone and granite) shells and salt. Moderate quantities of common clay products and sand have been produced. Records indicate that small quantities of petroleum, natural gas, sand and gravel, gems, bituminous rock, potash, mercury, gold, silver and platinum have been found. These resources will be briefly investigated in the following report to determine types, locations and potential development characteristics. Plate XV indicates known mineral deposits in San Mateo County.

Information about the quantity and value of individual resources is becoming unavailable because of the reduction in the number of industries involved and the policies of the U. S. Bureau of Mines in regard to publishing statistics. Figures that would disclose the operations of a single plant are not revealed, but are lumped into an unapportioned classification which indicates only total value. An examination of the manner in which Table 10 is presented makes it apparent that the number of mineral extraction industries in the county are being reduced.

The pressures of urbanization in San Mateo County have had considerable impact on mining activities. For the most part, the encroachment of urbanization has caused many of these on-shore operations to be phased out. As coastal metropolitan areas continue to expand and encroach on on-shore deposits, then off-shore areas will become targets for exploration. Sea shells, sand and silt are presently being dredged from the Bay and salt, bromine and magnesium are being recovered from ocean water. In other areas of the State, saline water conversion programs are gaining momentum and it appears likely that in the very near future this operation will be enhanced by including the extraction of mineral by-products. Exploratory operations off shore of San Mateo County have also begun for submarine gas, oil and heavy mineral or black sand deposits. The possible impact of off-shore resource development must be given some consideration in future planning policies.

SAN MATEO COUNTY REGIONAL PLANNING COMMITTEE

PLATE XV

Mineral Resource Areas

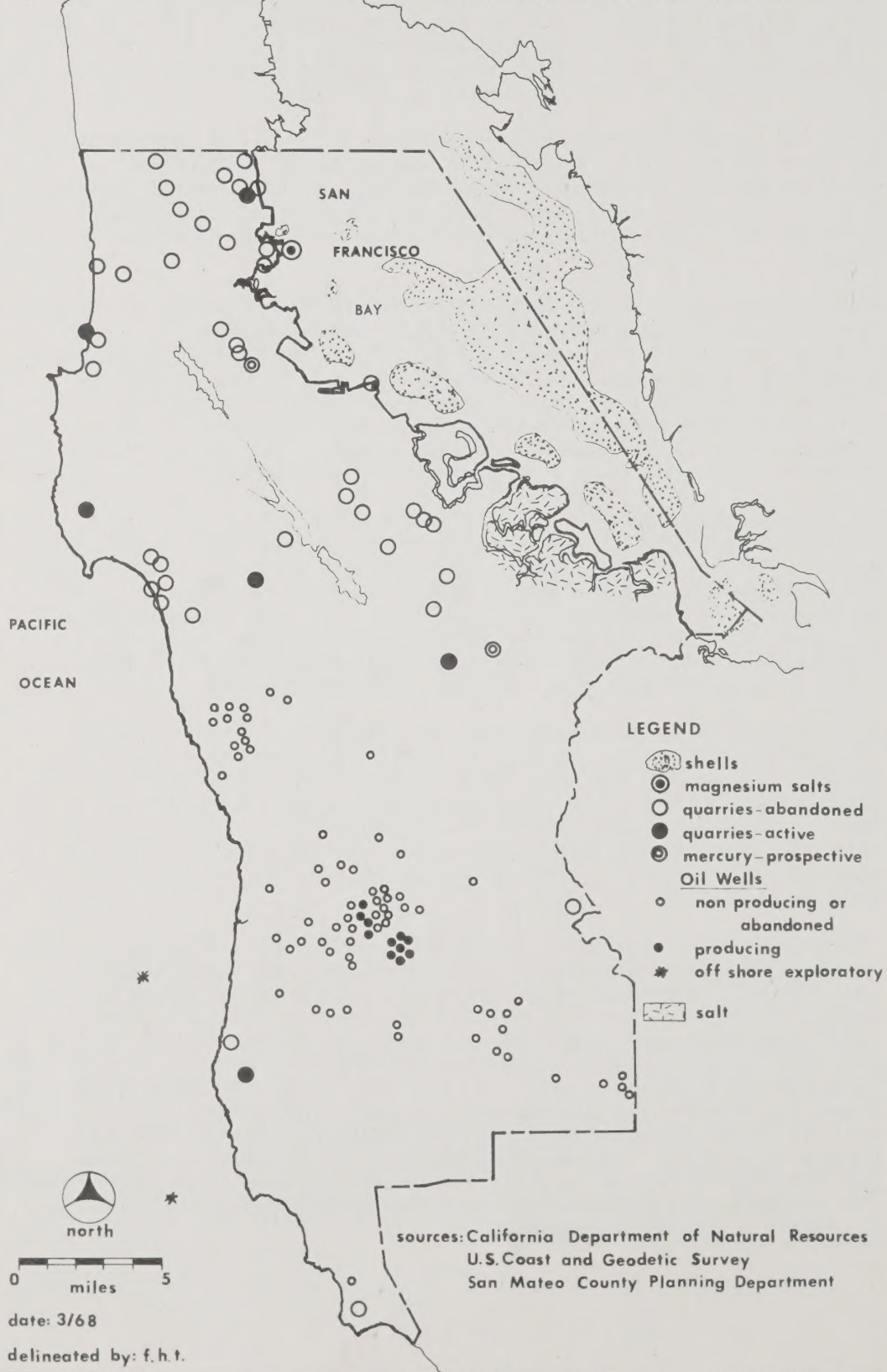


TABLE: 10
MINERAL PRODUCTION IN SAN MATEO COUNTY

Commodity	Unit	1964 ⁴¹		1965 ⁴²		1966 ⁴³	
		quantity	value	quantity	value	quantity	value
Natural gas	thousand cubic feet	3,146	941	2,518	1,000	2,105	-----
Petroleum	42 gallon barrel	54,637	160,016	43,521	117,000	39,000	-----
Stone	Short Ton	1,697,174	2,442,903	1,357,433	2,037,109	-----	-----
Sand and gravel	" "	193,000	175,000	-----	-----	-----	-----
Unapportioned	-----	-----	10,588,453 ^a	-----	12,354,404 ^b	-----	14,638,201 ^c
TOTAL VALUE			13,367,312		14,509,513		14,638,201

a Cement, clays, magnesium compounds and salt

b Cement, clays, magnesium compounds, salt, sand and gravel

c Cement, clays, magnesium compounds, salt, sand and gravel, stone, natural gas, petroleum

Source: See Footnotes Number 41, 42 and 43

SHELLS

Shell deposits constitute an important but not widely known mineral resource of San Mateo County. As early as 1849, an attempt was made to harvest native oysters for food, and in 1869, Eastern oysters were imported and planted along the Bay shore off San Mateo County. The oyster business did not meet expectations and in time the business ceased.⁴⁴ A limited number of shells were used for surfacing material such as garden walks in about 1891, although concentrated effort to develop the deposit did not begin until 1924. Shells were then dredged and processed for livestock feed and as a soil conditioner. By 1925, they had become a basic raw material in cement manufacturing. A process of extracting lime from shells and mixing it with bitterns from salt works to produce magnesium compounds was begun in about 1931 but little was sold commercially, and operation ceased in 1954.⁴⁵

Shell production and processing has involved only six major firms since 1924, and presently there are three. Employing hydraulic methods, barge operations have dredged an estimated 30 million tons of shells since 1924, the bulk of which has gone into the production of cement (Figure 25). Estimates of remaining resources are hard to determine as there has been little systematic effort in exploring known deposits or seeking new deposits.⁴⁶

Shell deposits have tended to accumulate with soft mud in shallow protected shelf areas of the bay where tidal currents are weak. Shell beds appear to be primarily composed of oyster shells with a few mollusks in beds of a maximum thickness of twenty-five to thirty feet. A sharp decline of the oyster population, coupled with wave erosion, is believed to have reduced the extent and size of shell beds. Increased pollution has apparently so decimated the native oyster population that live oysters are now difficult to find in San Francisco Bay.

The shell deposits are actually thin, low-grade unconsolidated limestone deposits that would be far less valuable or even economically usable if located on land. The present operation is possible due to:

- a) simple and inexpensive dredge mining
- b) bay waters provide inexpensive washing materials.
- c) bay mud on unwashed shells may be used as a source of alumina and silica in the manufacture of cement.
- d) low land cost, especially for an urban location.
- e) low cost, flexible transportation for products to large marketing area.

Problems of production arise:

- a) from the close proximity of the multi-use activities of dredging, landfilling, shipping, sport and commercial fishing and recreational activities.
- b) from the complexities of mineral ownership rights and jurisdictional controls of a large number of public agencies and private property owners.⁴⁷

Most of the known shell deposits are in shallow water areas which are most susceptible to landfill. If past trends in bayfill continue, it would appear that the proper utilization of these mineral deposits should be encouraged before the deposits are buried under fill. It is believed that the curtailment of shell dredging would be detrimental to the local cement industry and to the local chicken growers and egg producers, who are dependent upon this nearby source of raw materials.⁴⁸

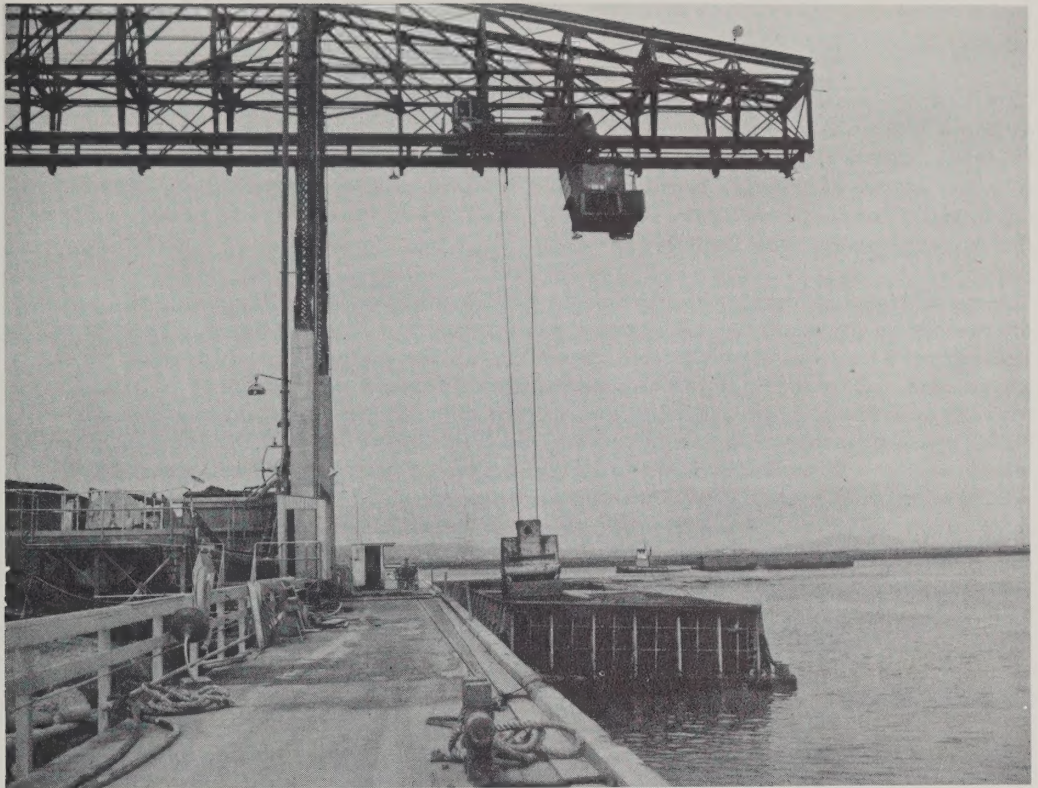


Figure 25: Oyster shells being removed from a barge for cement production. Note tugboat and other barges in background



Figure 26: Salt storage in Redwood City

SAND, GRAVEL AND ROCK

California's present annual sand and gravel output is about 120 million tons valued at about 139 million dollars. The sand and gravel industry is the State's leading mineral industry in terms of volume, and it shares top place with cement in terms of value among the State's hard minerals. These resources provide a less fluctuating and a more sound basis for operations than do many other activities within the mineral production industry.⁴⁹

The problems confronting the sand and gravel industry originate from the very nature of its operations. Like many other minerals, suitable deposits of sand and gravel are somewhat limited; however, unlike many other minerals, sand, gravel and rock commodities depend for their demand on density of population more than upon special qualities and rarity of occurrence. Because of their bulk, these commodities can not be moved long distances without incurring prohibitive cost. Urbanization needs large, adjacent source of sand, gravel and rock as building materials. Unfortunately, sand and gravel operations, due to dust, rock blasting and the movement of heavy trucks, are not compatible to the urban residential environment. Thus, the spread of population brings urbanization into competition with the sand and gravel for the acreage that constitutes a mineral resource.⁵⁰

Speciality Sands

The narrow strips of dune sand on the San Mateo County shoreline have in the past been mined on a small scale at Edgemar, Rockaway Beach, Pescadero and near Half Moon Bay. The sand from these deposits has been found to be satisfactory mix for asphalt and other types of road construction materials.

Black Sands

Black sands lenses may also be found along the coast in deposit of limited depth and lateral extent. This sand tends to be finer grained than dune sand and ilmenite and magnetite constitute much of the heavy mineral fraction of these sands. No production of black sand has been made.

Foundry Sand

Foundries produce numerous types of metal castings which require sand for the molds and cores. Sands from San Mateo County have been used in northern California since the earliest days of the foundry industry. Production has occurred on sand deposits in South San Francisco, Millbrae, and along the shoreline of San Francisco Bay. Production ceased in 1949 when a decline in foundry production and an increase in the use of synthetic foundry sand occurred. It does not appear that these deposits will be used again for this purpose.

Crushed Stone

The production of crushed stone has always been one of the principal mineral products of the county. Extraction has occurred chiefly from Franciscan sandstone and limestone, with smaller contributions in greenstone, chert, biotite, quartz diorite, Vaqueros sandstone and Cretaceous conglomerate. Most of this material has been used in road construction, although considerable quantities have been used as fill rock in the building construction industry. In the past,

quarry operations have occurred in the vicinity of Belmont, Woodside, Half Moon Bay, South San Francisco, El Granada, Pescadero, Rockaway Beach, Crystal Springs Reservoir, San Bruno Mountain, and near the head of Montara Creek.

Resource Potential

It is expected that the market for sand and gravel will continue to expand as California continues its remarkable growth. Depletion of these resource commodities can be expected within the next three generations unless sand and gravel deposits can be set aside as natural resource zones for future use.⁵¹

SALT

Early settlers in San Mateo County obtained salt from shallow tide pools which trapped and held ocean water until evaporated by the sun. Salt is an essential element of man's diet and may be used as a food preservative. Salt is used in large quantities by chemical industries which have access to a low-cost supply.

The geological occurrence of salt is varied. It may be found in almost unlimited quantities in ocean water, in marine sediment or non-marine deposits as rock salt, in brine wells, springs, saline lakes or salt flats. Whereas the chemical content of sea water is fairly constant throughout the world, inland sources of salt may differ in content due to the local factors which contributed to the deposit. Almost all inland sources have a history of intermittent production as a result of purification difficulties and high transportation cost. Nevertheless, the bulk of salt production is from these inland sources. California contributes only about six per cent of the nation's supply, and this is primarily produced from the solar evaporation process of ocean water (Figure 26).

Production Areas

The success of the commercial production of salt by the solar evaporation process requires an environment with the following four characteristics: 1) a consistently high evaporation rate, 2) a relatively low annual precipitation rate, 3) extensive low value-use tidelands, and 4) markets within close proximity or accessible by bulk carriers. These characteristics are found in the marshlands on the south end of San Francisco Bay.

The solar evaporation process of salt production works on the principle that as the mineral content of ocean water is increased by the slow process of solar evaporation, the various minerals contained in the salt water will reach a saturation point, crystallize and settle out of the solution. Ocean water is pumped through a series of concentration and crystallization ponds where salt and several by-products settle out.

The total mineral content of ocean water averages about three and one-half per cent, of which about two and three-quarter per cent is salt (sodium chloride). The remaining minerals include magnesium chloride, magnesium sulphate, calcium sulphate, potassium chloride, calcium carbonate and bromides.⁵² Several of these by-products crystallize and settle out before (and some after) sodium chloride. The solution remaining after salt crystallizes is called bittern, and is a concentrated solution which may be pumped out and transported by pipeline to neighboring chemical companies.

Resource Potential

The long-term prospects for a continued supply of salt and by-products from the solar evaporation plants in San Mateo County are uncertain. This uncertain future is also shared by a number of chemical industries adjacent to the Bay which are dependent on the salt plants for raw materials. The existing interdependency between salt plant and chemical industries is based on their close proximity which eliminates expensive transportation cost for raw materials. However, past trends indicate a steady decline in salt companies around the Bay. In 1900 there were 20 companies in operation. As early as 1936 salt companies were consolidating or discontinuing production due to increased taxes and the encroachment of urban development. By 1940, only three companies remained, two of which were centered in San Mateo County. Although the supply of import salt is plentiful, the cost of transporting it to bayside chemical industries appears to be so prohibitive they will probably be required to migrate to more favorable areas if bay salt plants discontinue production.⁵³

BROMINE⁵⁴

Bromine is most extensively used in additive compounds for gasoline, and smaller quantities are used in the manufacture of fire-retarding and fireproofing materials, fire extinguishers, fumigating mixtures, sanitizing additives for swimming pool water, bleaches, photographic emulsion laboratory, reagents and medicinal and pharmaceutical preparations.

Bromine is produced from the sea water bitterns left over from the solar evaporation of salt process. These are pumped to chemical companies for processing. The bittern contains 0.175 per cent bromine which is recovered during the first step of a process that also produces magnesia.

Resource Potential

Sea water, the basic raw material for bromine, is essentially unlimited. However, the industrial plants that supply the bitterns from which bromine is extracted may someday cease production. Unless resource preservation areas are established, it appears that the salt industry which supplies the bitterns may convert their salt evaporating ponds to other types of development.

OIL AND GAS

Oil and gas deposits of commercial quantities occur under pressure in the interconnected pores of reservoir rocks, in pools or fields. A reference to underground oil automatically includes gas, since all oil deposits contain some dissolved gas. The production of oil and gas is an important economic activity in California. It provides a basis for employment, investments, royalties, taxes, and a local source of energy required to support a large industrial society.

Natural gas is used primarily for space heating and as a fuel, with lesser amounts being used as a chemical raw material. Oil is used primarily to produce energy for power or heat although the petroleum industry makes at least 2,300 separate products from crude oil.⁵⁵

The presence of oil was noted in San Mateo County as early as 1865. Shortly thereafter, production from a shallow 700 foot well had begun.⁵⁶ Since that time, improvements in exploration and drilling techniques have facilitated the recovery of oil from deep wells in excess of 8,000 feet. Locations of producing and non-producing well sites are indicated on Plate XV. In December of 1967, there were eleven producing wells in the county, of which eight were producing over 150 barrels of crude oil or over 10,000 cubic feet of gas per month.⁵⁷

Off Shore Exploration

At least four major oil companies have conducted submarine oil and gas exploration operations along the California coastline adjacent to San Mateo County since 1963. Tests so far have not been permitted closer than one mile from shore. Initial exploration operations have involved two continuously moving boats exploding five to ten pound dynamite charges to obtain seismographic readings. In 1967, at least two exploratory drilling operations began beyond the three-mile limit in water over 200 feet deep. These areas were located off shore in the vicinity of Pigeon Point. If oil or gas is located, off shore floating plants will fit producing wells with well head completion units that will not protrude more than 30 feet above the ocean floor.

Although the county is not directly involved in these off shore matters, inspectors from the U. S. Corps of Engineers, the State Lands Commission and the State Department of Fish and Game conduct investigations to ensure that all regulations are complied with.

Resource Potential

The complex geologic structure in California forms innumerable traps in which oil and gas may have accumulated. Although most of the obvious traps in the principal basins have been tested by exploratory drilling, many obscure traps certainly exist. Discoveries in recent years show that oil resources can be found in already highly explored areas. It is now generally believed that the most favorable localities for new discoveries are in areas of proved oil generation within the principal productive sedimentary basins.

The potential resources of oil and gas within the bay and in the Pacific coast, not only within the boundaries of the State but also on the Federal lands outside the three-mile line, are believed to be large.⁵⁸

BITUMINOUS ROCK

Records indicate that there is only one minor deposit of bituminous rock in San Mateo County. Some rock was used for private road work pre-1919. The importance of this natural resource to the county would appear to be in its development potential.

Nearly all the deposits in the State are in sedimentary rocks of Miocene to recent age in the California Coast Ranges, Transverse Ranges and the Peninsular Ranges provinces. The deposits frequently occur at the surface near the margin of the sedimentary basins, or in the basins where some rocks are near the surface as a result of folding or faulting, or where oil has migrated along faults.

The primary use of bituminous rock in California in the past has been for road-paving materials. Past extracting processes have produced native asphalt, crude oil, and a lightweight concrete aggregate and pozzolan by burning quarried bituminous rock.

The production of native asphalt was long ago terminated. The production of bituminous sandstone was terminated by 1949 as petroleum asphalt from refineries captured the market for road-paving materials. A limited production of concrete aggregate and pozzolan is still being engaged in. The production of crude oil from bituminous rock has not been done since 1959, and can not match the competitive cost of well produced crude oil. However, it seems likely that the future use of bituminous rock will be for its oil content, if a method of extracting oil from the rock without quarrying can be perfected.⁵⁹

CLAY

The clay found in San Mateo County is classified as a "miscellaneous clay" by the industrial classification system utilized by the U. S. Bureau of Mines. This class covers a variety of clay materials, usually mixtures. Miscellaneous clays have a variety of uses, as a raw material in the production of portland cement, for expanded shale aggregate and for heavy clay products.

Natural clay deposits in the county which have been worked from time to time are located near Cooley's Landing, near Millbrae Station, and at tidewater east of South San Francisco. These deposits have been used to manufacture bricks and sewer pipe. Some local clay has been upgraded by blending with imported clays for the production of sanitary porcelain products.⁶⁰

It appears likely that the outward spread of urbanization and bayfront development has permanently restricted the future use of county deposits. Since large deposits of miscellaneous clays appear to be available in other locations, recovery operations will probably not be re-initiated in San Mateo County.⁶¹

CHROMITE

Small masses of low-grade chromite have been located in San Mateo County in extensive bodies of serpentine adjacent to the San Andreas Fault zone. The chromite is localized near Crystal Springs Reservoirs.⁶²

Chromite, as the only economic source of chromium, is an essential commodity for modern industry. Although magnesite can be substituted for much of the chromite in refractors, there are no satisfactory substitutes for chromium in the metallurgical and chemical industries. It is used metallurgically in steel alloys for strength and resistance to corrosion, and in high-temperature furnace linings. The chemical industry uses it to make dichromate as a basis for dyes, tanning and chromium plating.

The United States has in the past, as well as presently, been unable to meet its chromite needs from domestic deposits. Production dropped sharply in 1958 when governmental purchase programs ended. It appears that the United States will depend increasingly on imported sources as the record of chromite production clearly shows the impact of declining reserves and increased difficulties in mining.⁶³

SILVER

Silver, rarely found alone in nature, usually accompanies other metals such as gold, copper, lead or zinc and is frequently produced as a by-product of base-metal mining. Thus the prices of these metals have a greater influence on silver production than do fluctuations in the price of silver alone. Silver is used in money systems, for sterling silverware and jewelry, in electrical and electronic uses, in brazing alloys and for dental and medical purposes.

The greatest silver resource potential probably still lies in undiscovered or unmined deposits of copper, gold, and lead-zinc ore which will probably also yield silver ore. Due to this close association to gold, silver deposits throughout San Mateo County are assumed to be basically those identified in the following section on gold.

GOLD

Minor occurrences of lode and placer gold have been reported from several mountain and coastal localities throughout the county; however, none have been of sufficient extent or richness to be of economic importance. Gold has been found along Pescadero Beach, Dennison Creek, Tunitas Creek, and in the vicinity of the Stanford Estate, Searsville Lake, and on Black Mountain in the San Bruno Mountain group.

The principal use of gold at present is in monetary systems. Considerable amounts are used in jewelry, decorative art, dentistry and lesser amounts in the chemical industry and glass making. Its properties of resistance to corrosion, reflectivity, malleability and high specific gravity have been utilized in the production of new scientific devices and instruments.

At the present time, the outlook of gold mining in California is poor because: 1) many of the workable deposits have been largely depleted, 2) of the great expense in reconditioning mines, 3) in many districts land values have been so greatly increased in recent years as to preclude their use in mining again, and 4) of inundation of many important mines and gold bearing areas by reservoirs.⁶⁴

SEMI-PRECIOUS GEM STONES.

Wave action has produced some deposits of natural polished pebbles of semi-precious stones along the county's coastline. The most striking accumulation occurs at Pebble Beach where wave action has removed pebbles from beds of Cretaceous sandstone and shale.

The pebbles are composed of siliceous minerals which are highly resistant to abrasion, translucent to opaque in texture and may appear in a wide variety of colors. The pebbles, which include agate, chert, hydrolite, jasper and onyx, have in the past been produced commercially for jewelry. The Pebble Beach section is now included in the San Mateo County Park system, and removal of pebbles is illegal.

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THE VEGETATION OF SAN MATEO COUNTY

This section will report on the distribution of plant resources in San Mateo County. Plant cultivation is the basis for the production of food needed by the urban population and for the production of wood products needed to construct the city and for fibers for clothing, for newsprint, etc.

The plants mentioned in the following discussion are not intended to be an exclusive listing of the plants to be found in the various plant zones of the county, but are intended to be characteristics of the zone. Detailed plant lists are available from other sources, some of which are listed on the reference pages of this section.

PLANT ZONES:

The evolutionary processes of plant invasion and succession, as influenced by climate, soil, topography, man's treatment of the land, and other factors, have combined to form a diversified and complex pattern of vegetative types throughout San Mateo County. Plant zones are created by the degree to which each of these factors is an influence in controlling growth. (See Plate XVI)

The influences of weather create plant climates in which a common set of temperature ranges, humidity patterns and other geographic and seasonal characteristics combine to allow certain plants to live and others to fail. There are at least six significant influences comprising a plant climate.⁶⁵

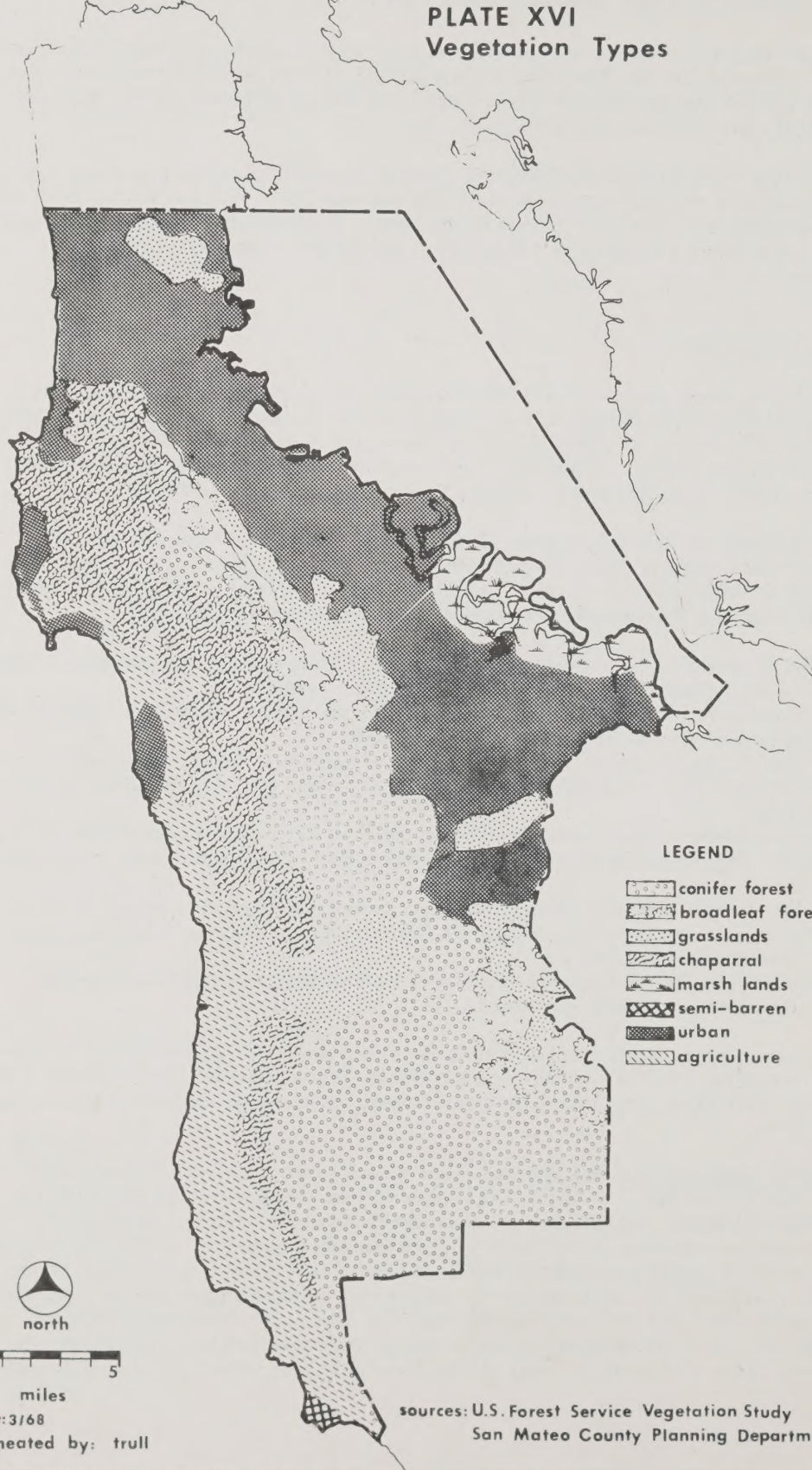
- 1) The distance of the area from the equator is influential in the number of hours of sunlight and the length and duration of cold weather.
- 2) Elevation increases are reflected in colder and longer winters in addition to comparatively colder nights all year round.
- 3) Topographic barriers, such as the coastal mountain range, influence the movement of marine air and continental air flows and precipitation distribution.
- 4) Areas predominately influenced by continental air masses have colder winters, hotter and dryer summers with more irregular precipitation than do coastal areas.
- 5) Local terrain and the phenomena of air movement in which cold air settles and warm air rises create cold air flows from hillsides and cold air basins in low-land settlement areas.
- 6) The Pacific Ocean influence modifies climatic factors to promote moist, mild winters and cool summers.

The influences of temperature on land use is a restrictive power which increases with advancing latitude and higher elevations. When prevailing temperatures are so low that killing frost may occur any month, it generally excludes crop-oriented activities.

Plant hardiness zones, for example, are based on the observation that plant survival and growth is related to the extreme low temperature of the area. In San Mateo County, unprotected plants must be hardy enough to withstand cold temperature extremes of 20° to 30° F. In the other extreme, direct-heat injury may occur to newly germinated tree seedlings if the surface-soil temperature rises above 120° F., a temperature not unusual on bare ground in full sun, and frequently exceeded on south-facing slopes or black soil surfaces. Although plants vary in environmental needs, average daily temperatures of 43 degrees produce signs of growth in many plants and within a certain range, an increase

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PLATE XVI
Vegetation Types



LEGEND

- conifer forest
- broadleaf forest
- grasslands
- chaparral
- marsh lands
- semi-barren
- urban
- agriculture



north

0 5
miles

date: 3/68

delineated by: trull

sources: U.S. Forest Service Vegetation Study
San Mateo County Planning Department

of 18 degrees nearly doubles growth rates. In other cases, a lack of extreme temperature changes may be detrimental to plant growth.⁶⁶

The growing season of the county's coastal forest and agricultural districts approaches 319 days per year.⁶⁷ In areas of higher elevations there are greater extremes in daily and seasonal temperatures and the growing season is somewhat reduced but generally not less than 260 days per year. The frequent chilling fog creates unfavorable coastal conditions for raising such crops as corn and tomatoes; however, speciality crops, such as flowers, artichokes, cabbage, brussel sprouts and other root crops flourish. Redwood and fir trees also thrive in the shrouded misty and foggy canyons of the coastal area.

Redwood trees and the grass land areas of the county on which cattle, sheep and deer graze are dependent upon fog drip as a source of moisture. Without fog, the sun and hot, dry continental winds can dry out vegetation and seriously damage cold weather crops such as artichokes and brussels sprouts.

Another natural condition, that of soil character, has a subsurface influence on plant growth. The predominant vegetative cover of an area reflects plant tolerance to soil acidity or alkalinity and mineral soil composition. The physical characteristics of soil particles, influencing bonding, drainage, aeration and hardpan formation introduce limitations for shallow and deep rooted plants.

Plant resources may be classified into two major settings: 1) the cultivated setting, either urban or rural, where man's activities are predominant determinates of plant types and growth, and 2) the primeval setting, which is an area denoting a predominant natural growth determined pattern.

THE CULTIVATED PLANT SETTING

Many of the natural limitations on vegetative types may be modified by man through the application of fertilizers, irrigation, the use of earth-working equipment, greenhouses and the planting and cultivation of new plant species. Man-made changes of plant setting are evident in both the agricultural and the urban areas of San Mateo County.

Urban Plants

The majority of the county's population now lives in the urban environment, a physical setting often with a minimum of native or cultivated plants (Figure 27). In built-up urban areas of two to multi-story structures, the buildings dominate the scene, and when the occasional urban park appears, it is as a contrasting green space between large building masses. The pattern of houses and streets in suburban areas can be pretty monotonous unless topography and vegetation provide some variation. Subdivision developments provide suburban property owners with many combinations of land qualities, topsoil or exposed subsoil or rock, upon which the owners cultivate grass, trees and other plants. The better residential districts, institutional grounds and parks, where fine old trees survive, become the show places of the city.

Growth Requirements

Vegetation within the urban setting must tolerate almost impossible conditions of soot, dust, smog, glare, carbon monoxide and barren soil, predominately covered with hard surfacing. Growing conditions are difficult and plant locations are exposed to extremes of heat and cold, excessive moisture or drought, high winds and turbulence from passing vehicles.

Vegetation in the urban setting moderates climate, by reducing extremes of heat, wind, and aridity. Cultivated plants create volumes of shade, they diffuse bright light and glare, and they modify the visual landscape by introducing texture, and color. Landscape planting can screen unsightly areas from view, and can insure privacy. Plant materials can be used to delineate open space or to control drifting sand in areas where it is a problem.

Plants growing in the urban setting must conform to certain urban requirements. The trunks and roots should not push and swell enough to disrupt sidewalks and driveways. Urban plant species must not have aggressive root systems which will clog sewer lines. The plant tops must not create troublesome messes or do damage to cars and other property from drippings of insect-infested plants or from leaves, twigs, flowers or fruit. The plant species must be hardy. Mature plants must fit into the dimensions of available space. Plants must not grow too tall or too broad or too dense to impair visibility of intersections, traffic signals or light from street lights. Undesirable too, are those plant species which have thorns, spines or poisonous characteristics jeopardizing the health and safety of urbanites. These requirements make it a challenge to grow any trees of significant size in urban areas; all too often our big trees have been chopped down, and replaced by inoffensive little things that will never amount to much.

A special complication peculiar to the vegetative types growing in the semi-arid climate of San Mateo County is the problem of fire. Certain types of vegetation which cover the county's hillsides becomes very dry and inflammable during the



Figure 27: The urban environment with a minimum of plant materials



Figure 28: Flower cultivation in an agriculture setting

dry season of the Pacific Coast, especially during years of subnormal rainfall. The scattered and intermittent large lot dwelling or summer home development in rough topography is most vulnerable to brush fire. These developments are surrounded by large masses of fire fuels in the flammable forest and range materials which frequently grow right up to the structures. In some instances the street system provides poor routes of access for fire fighting equipment and some streets dead end, thereby creating the possibility of trapping inhabitants in the area. Fire codes which pertain to this type of development are found in the State Division of Forestry's "Forest Practice Rules For Redwood Forest District."

Agriculture

Many plant resources of the county were used in their natural state by the Indians and Spanish cattle raisers. A marked transition in vegetative types occurred in the late 1800's when Italian and Portuguese immigrants, who had a native talent for growing speciality and common vegetables, settled in small groups on the coastal areas. As the population of San Francisco grew and transportation facilities improved, the coastal areas of San Mateo County became a thriving supplier of garden vegetables.⁶⁸ The idea of "land abundance" dominated agricultural activities, land use was explorative and many steep soils were cultivated intensely which resulted in sheet and gully erosion. Since about 1925, when the peak utilization of land for agriculture in terms of acreage was apparently reached, farm acreage has decreased as a result of urbanization and previous improper cultivation practices which caused heavy soil erosion (see Table 11). Although much of the erosion problem has now been arrested, urban encroachment continues.⁶⁹

The County's Soil Conservation District indicates that there are at least three influences which tend to bring about shifts in land use away from agricultural to more intensive urban uses. "One of these influences is the diminishing land available for urban development in areas outside the coastal region. A second is the high development cost in some areas now partially urbanized. A third is the anticipated reduction in major transportation barriers to and from the coastal region." ⁷⁰

Present agricultural activities are generally restricted by suitable soil, available irrigation water supplies, the fog belt and steepness of slopes. On the gentler slopes of higher upland areas, above 500 feet elevation where irrigation water is not available, dry farming techniques produce crops of hay, grain, flax, peas and horsebeans. Crop yields in some of these upper areas are not high due to past erosion and lower soil fertility.

The irrigated lands of the county which are level, and generally lie below a 500 feet elevation are being utilized to produce a variety of speciality crops, such as water cress, flowers, artichokes, brussel sprouts and minor crops of apples and nuts.

The flower industry of San Mateo County, although very small in land area occupied, is of considerable economic importance (Table 12).

TABLE: 11

AGRICULTURAL LAND USE IN SAN MATEO COUNTY
(Acres)

Year	Crop and acreage				Total:	Total		Source
	Truck	Field	Field	Fruit	crop-	Pasture	agricul-	of
	crops	flowers	crops	and	land:	area:	area	data ^a
1909	3,648 ^b							1
1919	7,142 ^b						77,736	1
1930	9,180 ^c							2
1941	11,963	1,135	23,704	623	37,425			3
1945	11,726	887	26,596	528	39,737			3
1946	9,982	1,123	21,581	521	33,207			3
1948	7,583	1,295	27,845	481	37,204			3
1952	6,058	1,367	23,044	397	30,866			3
1954	6,335	1,279	23,995	378	31,987			3
1955	5,739	1,234	24,681	380	32,034			3
1956	5,593	1,280	23,128	428	30,429			3
1957	5,734	1,146	23,623	397	30,900			3
1958	5,067	1,119	19,185	381	25,752	---	---	3
1959	4,837	1,004	18,576	382	24,799	33,131	57,930	3
1960	4,653	921	17,932	350	20,856	35,904	56,760	3
1961	3,880	894	16,778	283	21,835	35,760	57,595	3
1962	3,837	780	15,090	279	19,986	38,725	58,711	3
1963	3,184	798	11,537	278	15,797	39,825	55,622	3
1964	3,192	753	10,071	259	14,275	40,365	54,640	3
1965	3,097	710	10,176	164	14,147	39,780	53,927	3
1966	3,306	729	8,010	233	12,211	40,660	52,871	3
1967	3,533	703	8,219	242	12,697	37,025	49,722	3

a. Sources of data:

- (1) 1920 census, Volume VII, Irrigation and Drainage
- (2) 1940 census, Irrigation of Agricultural Lands
- (3) Annual reports of the San Mateo County Department of Agriculture.

b. Represents total irrigated area. May include crops other than truck.

c. Represents irrigable land for all irrigated crops.

TABLE: 12
AGRICULTURAL PRODUCTION VALUES
(in dollars)

Year	Truck Crops	Field Flowers	Field Crops	Seed Crops	Fruit & Nut Crops	Livestock & Poultry	Livestock Poultry & Apiary Prod.	Totals
1955	3,560,600	7,416,231	933,834	---	219,559	2,559,532		\$14,689,756
1956	4,126,504	7,847,796	865,736	---	250,512	2,700,809		15,791,357
1957	3,328,737	8,604,529	913,060	---	332,912	2,595,491		15,774,729
1958	4,722,720	8,748,600	394,170	---	277,978	3,010,883		17,154,351
1959	4,951,026	9,063,658	734,203	16,306	268,715	1,986,361	797,549	17,817,818
1960	5,134,290	8,924,590	671,992	29,100	306,980	1,542,092	780,030	17,389,074
1961	4,484,650	8,995,800	717,030	26,400	208,310	1,240,872	721,350	16,394,412
1962	4,571,800	8,839,100	662,710	40,000	153,810	1,147,310	802,480	16,217,210
1963	4,239,930	10,869,850	497,110	16,600	274,220	1,147,660	702,300	17,747,870
1964	4,304,216	10,935,350	609,190	36,250	443,370	995,320	679,590	18,003,286
1965	4,335,055	12,054,680	500,830	7,490	252,030	875,920	625,246	18,633,251
1966	4,861,215	12,365,980	512,800	4,490	246,778	1,547,370	587,484	20,126,117
1967	5,978,520	16,759,550	543,670	22,970	262,320	1,825,150	639,972	26,032,152

Source: Annual Reports of San Mateo County Department of Agriculture.

Flower growing in the county is a highly specialized business, requiring large initial investments and high maintenance cost. This west coast based agricultural activity is in competition with other flower growers for an east coast based market. The county's flower industry has a natural advantage in mild winters, which reduces the cost of greenhouse heating over eastern growers, but is handicapped by the shipping distance and the cost involved. Local growers are seeking to overcome the distance deficit with higher production and better quality at lower costs.²⁸

In addition to the obstacle of distance, local growers have noted that as early as 1952, air pollution has injured carnations, orchids and several other greenhouse crops.⁷¹ Some greenhouses have been fitted with a special type of air filter to try to remove the chemicals which cause crop damage.⁷² Other local growers have moved from the bayside of the county to the coastside where air pollution is believed to be less severe.

Brussels sprouts and artichokes are grown on large acreages because these plants thrive in the coastal climate. Brussels sprouts appear to be the most promising major crop. They can grow well in soils 2-1/2 to 3 feet deep, and the mechanical equipment and other connected operations can utilize slopes up to 20 per cent.⁷³ In 1962, the county produced about 43 per cent of the state's total production which was about 90 per cent of the nation's brussels sprout market.⁷⁴ Peas, spinach, and barley are frequently used as alternate plants to provide crop rotation which is necessary to control the clubroot disease associated with brussels sprout production.

Soil suitable for deep rooted crops under irrigation are generally located in the watersheds of Denniston, Frenchmans, Pilarcitos, Arroyo Leon, Pescadero, Butano, Cascade and Greenoaks Creeks. Soils adapted to shallow rooted crops under irrigation may also be found in or adjacent to these fore-mentioned areas.

Resource Potential

In a recent publication of San Mateo County's Soil Conservation District, it is stated that federal and state water agencies anticipate that the expansion of urban development will progressively move southerly along the coast so that by 2075, half of the county's prime agricultural crop land will go out of production. It is also assumed that irrigated crop land will be maintained in the intervening years but only below the 500 foot elevation contour because of steeper slopes and the higher cost of supplying irrigation water above that line.⁷⁵ Past census and county records indicate a steady decline in truck, flower, fruit, nut and other field crops, with a corresponding increase in pasture acreage.⁷⁶ The cost-price squeeze of farming and increasing property taxes make it difficult, if not impossible, for the smaller agricultural enterprises to stay in business. Only speciality crops appear to have a real chance in the present competitive economy. The Soil Conservation Service indicates that speciality crops assume the following order according to their abilities to pay for irrigation water: 1) flowers, 2) strawberries, 3) brussels sprouts, 4) miscellaneous truck crops, 5) artichokes and 6) irrigated pasture.⁷⁷

Existing tendencies in county land utilization appear to favor the ultimate use of land on the coastal side as urban. Once these areas are urbanized, it appears highly unlikely that the land will ever be returned to agriculture. The county and the City of Half Moon Bay, utilizing the Agricultural Conservation Act of 1965, have as of the time of writing, undertaken to preserve some 32,400 acres of agricultural land under a ten year agreement with the property owners.

The land involved in this conservation activity serves dual purposes in the reservation of farm and open space lands. Most of the land covered by this agreement is of a grazing, timber or watershed land type, and very little prime agriculture land producing crops is presently covered.



Figure 29: Grasslands of San Mateo County



Figure 30: The beginning of the chaparral zone

THE PRIMEVAL SETTING

The primeval setting is usually destroyed as the urban areas encroach into the countryside and change the natural ecological system of ground forms, rocks, plants and water. Although many of the preservation areas in San Mateo County have not been established for the chief purpose of protecting plants, the plants growing there are in effect preserved. Areas in San Mateo County where the primeval setting is preserved include Stanford University's Jasper Ridge Reserve, which protects a variety of plant types on a 1.1 square mile property; Palo Alto's Bird Preserve includes bay marsh plants; and Fitzgerald Marine Preserve, located on the coast side of the county, protects coastal marine plants; the San Francisco Watershed land (35 square miles), the County Park (3.0 square miles), Portola State Park and Butano State Park (both 7.0 square miles) preserve a variety of plant materials, including cutover and virgin stands of Redwood.

The county has a total of 552.9 square miles of which 448.3 square miles are land, 3.9 square miles of inland water and 100.7 square miles of tidal water. As of 1960 the 448.3 square mile land area was divided into 77 square miles of urban land use - 57 square miles in residential, 4 in commercial, 10 in industrial and transportation, and 6 in institutional land use - salt evaporators occupied 10 square miles and marshlands occupied 5. The remaining open space, 356 square miles is easily identifiable with the primeval setting. The more man's activities come in contact with the natural state, the more the natural state recedes.

San Mateo County still has a substantial amount of land that can be retained in the primeval state. If much of this setting is to be retained, the residents of the county must 1) become aware of the pressures of urbanization as a threat to these areas, 2) devise a workable action program to protect the environment and 3) take action immediately to carry out the preservation program.

It appears that the threat of urbanization for the county's primeval lands comes primarily from 1) population pressure and 2) from economic pressure.

Regarding population pressure, any city or county or region does have the option of saying when they have reached a saturation point in population. A local political jurisdiction does have the right, and the power, to set standards which establish a ceiling beyond which growth is not permitted. Locally, the cities of Colma, Hillsborough, Woodside, Atherton, and Portola Valley have taken just such action. It appears probable that there is still room for substantial population increase in other presently urbanized areas of the county, and that a total population of 1,000,000 can be accommodated in our county (see County Master Plan, 1958 edition, page 13), without making substantial inroads on our primeval areas. It appears that we can have both substantial urban development and the preservation of primeval areas, IF WE PLAN FOR IT AND IF WE PUT OUR PLANS INTO PRACTICE.

Concerning the economic pressure on primeval areas: we need new methods of keeping the economic pressures off rural areas, so that they may stay rural. The county's current program with the Agricultural Land Conservation Act is an important and effective step in this direction, but it does not appear to be a full and complete answer to all the needs of the county and of the private property owners. We are hopeful that the State Legislature will develop effective new programs, in accordance with State Constitutional Amendment No. 4, which was adopted in 1967, and was a mandate of the people expressing the policy that open space

should be protected where appropriate and possible.

City, county, regional, state, and federal governments need to cooperate in order to : 1) define policies which will build the urban areas we want, and 2) which will preserve the primeval areas we want to save. Furthermore, government, in cooperation with private property owners, must devise workable and equitable methods of relieving the economic pressures which are now threatening our primeval lands.

Conifer Forest

Timber conifer forest are located in the upper elevations of the south central portion of the county. Dense stands of Coastal Redwood (*Sequoia sempervirens*) and Douglas Fir (*Pseudotsuga taxifolia*) occur naturally in the larger canyons and on the cooler and moister ridges. Harvesting operations are primarily orientated to the production of conifer saw timber.

TABLE: 13
TIMBER PRODUCTION IN SAN MATEO COUNTY 1965

Number of timber operations ^(a)	Veneer logs and sawlogs (MBM)	Pulp Wood (MBM)	Miscellaneous forest products ^(b) (MBM)	Total (MBM)
14	25,424	42	325	25,791

MBM - Million board feet

a) Includes active timber operators engaged in production of miscellaneous and other forest products.

b) Includes split products, poles, piling, fence posts, and cordwood.

Source - State of California, Documents Section. "California Statistical Abstract 1967," p. 137.

Christmas tree farms, primarily of Douglas fir, are located where soil and moisture conditions are favorable. At least one logging company is utilizing slash and sawdust to produce timber by-products. Hardwood trees are cut in limited amounts for fuel.

The most significant of San Mateo County's plant resources is the Coastal Redwood. It gives a distinctive character to certain areas of the county with its thick, shaggy, semi-fire resistant trunk and its average height of 150 to 250 feet. Fog and Redwoods combine to create unusual settings which have become of historic and biologic interest.³¹

Redwoods were protected from early historic harvesting because of their remote location and due to the fact that the early Spanish settlers made few demands on timber resources. The early Americans created a demand for redwood timber and in line with the early laissez faire attitude, harvested them as an inexhaustible resource. Present day cutting is tempered by sustained yield management policies and preserve dedications. California's State Park system, in 1964, had set aside 102,689 acres of redwood lands, of which 48,333 were virgin stands. Two of these are in San Mateo County, Butano State Park with a total of 2,176 acres and Portola State Park with 1,740 acres were set aside, of which 1,500 and 1,400 acres respectively, are of virgin growth.⁷⁸ Virgin stands are also found in the county's Memorial Park.

Redwood survival depends not only on its immediate environment but on the entire land unit which lends its character to these stands. The redwood ecological balance undergoes subtle changes when it is touched by roads and freeways, timber cutting, erosion, mineral entry, water control projects, air pollution and even park development. The redwood habitat includes areas of shallow and unstable soil where the relatively shallow rooted redwoods frequently undergo wind damage or when logged, erosion problems arise, especially in the siltation of stream channels. The nature of the hydrologic cycle and how it influences or is influenced by the behavior of precipitation, temperature, parent rock, soil properties and stream and ground water behavior appears to be unusual in the redwood habitat. Dense, cool redwood groves apparently derive additional amounts of moisture from fog and influence the precipitation to evaporation ratio thereby conserving soil moisture. The stress for moisture in older stands is believed to cause "spiked-topped" or dead tree tops.

The ecological balance of the redwood habitats is complicated by the fact that redwood seeds have a poor survival ratio because they are highly susceptible to heat injury, certain insects and fungi. Regeneration is most likely from sprouting around stumps, but the sprouts, unlike the mature tree, are highly susceptible to fire.

The Douglas fir is the most common of the county's evergreen and is the principle source of construction lumber utilized on the west coast. It competes with the redwood for space in damp, cool areas and survives on dryer slopes where the redwood fails. The fir is grown as a Christmas tree and is used extensively in landscaping. It reaches heights of about 180 feet under favorable growth conditions.

Other species of conifers sometimes found in interrupted stands within and adjacent to the timber conifer zone are several species of pine. The most common one is the Monterey Pine (*Pinus radiata*). The Knobcone Pine (*Pinus attenuata*) and the Bishop Pine (*Pinus muricata*) are found in small clumps or as single trees spread through the Santa Cruz Mountain slopes.



Figure 31: The conifer forest provides a unique recreational setting



Figure 32: A roadside view of the broadleaf forest

Intimately associated with the Redwood-Douglas fir forest are several hardwoods, such as the Tan Oak (*Lithocarpus densifloral*) and the Madrone (*Arbutus menziesii*). In competition with the other species, the Madrone usually acquires curved, odd shapes as it struggles to reach small patches of light coming through the high forest canopy. Unusual free standing Madrone may sometimes appear when a fire or climatic factors take out other species. The Tan Oak competes with firs and redwoods by growing vertically and its bark is usually partially covered with mosses and lichens. The bark is a source of tannin which is a chemical used to tan leather.

Broadleaf Forest

The majority of trees growing in these areas generally have broad, flat leaves which undergo marked seasonal changes. This forest illustrates spring with bright budding growth, the summer season with lush natural growth, the fall with colorful blowing leaves and the winter with interesting tangles of bare branches.³¹

The stream valleys of the broadleaf forest generally provide a plant habitat protected from winds, cooler in temperature than hillside areas, and abundant in shade and moisture. Ground conditions are generally damp, cool and contain high quantities of organic materials. Animal life is abundant. The stream banks have their own characteristic species, most evident by the presence of the Arroyo Willow (*Salix lasiolepis*) which is only one of a number of willow species common to the area. Willows tend to hold soil in stream beds, and slow "flash floods" type runoff. The Arroyo Willow usually grows in dense stands which seldom exceed a height of fifteen feet.

Growing alongside the willows are taller trees, up to 60 feet, such as the Big-leaf Maple (*Acer macrophyllum*) with a broad palmate leaf and winged-shaped seed. This tree has some of the largest leaves of any common local plant. The leaves turn a brilliant yellow in the fall. Also of common occurrence along stream-sides are the Oregon Ash (*Fraxinus latifolia*), and the California Laurel or Bay (*Umbellularia Californica*) which has smooth, dark green leaves that are dried and used as seasoning in cooking. Although the Laurel normally grows to about 30 feet, one of the largest California Laurels in the state grows in San Mateo County. It is located just off Sawyer Camp Road in the San Francisco watershed.

Tall, slender Poplars, which have frequently been planted throughout the Bay Area as wind breaks, have established stands as a result of the wind distribution of its white, cottony seeds.

Scattered throughout the broadleaf forest is the California Buckeye (*Aesculus Californica*) which has a heavy palmate compound leaf development and a fruit which can be eaten by rodents, birds and man.

Numerous species of oak grow on the wind exposed, drier slopes of the Broad-leaf forest. Although most oaks drop their leaves annually, there are two ever-green oaks, the Coast Live Oak (*Quercus agrifolia*) and the Interior Live Oak (*Quercus wislizenii*) growing naturally in this forest area. The Black Oak (*Quercus douglasii*) which has a smooth whitish bark and grows to about 50 feet, produces an acorn which was steamed and ground up to make mush by the Indians and early settlers. The California Black Oak (*Quercus kelloggii*) is an impressive 80 foot tree of value to wildlife as forage and shelter. The Valley Oak (*Quercus lobata*) grows most abundantly in the drier parts of this area. The lumber of the Oregon Oak (*Quercus garryana*) which seldom exceeds 50 feet, is of great economic value when used in the manufacture of furniture, flooring, fence post and as veneer.

Grasslands

Plant life throughout the grasslands is generally restricted by high afternoon temperature, infrequent precipitation, thin soil and plant isolation. Plant species generally vary according to the two topographic features of 1) gullies and 2) open slopes.²⁹

The gullies are somewhat protected, have leaf litter, a smaller evaporation rate, and more fertile soil than open slopes, which enables gullies to provide a favorable plant zone for shrubs and trees.

Open slopes generally have thin, unfertile soil which is broken by rock and large boulders. Although winter rains provide a short growing season, the low absorption capacity of the thin soil, and the high evaporation loss caused by hot and sunny afternoons combine to severely limit moisture supply. In some areas, frequent coastal fogs provide subsistence moisture.

Many of the vegetative types which can be found in the grasslands have been imported or have escaped from farms and gardens in the region. The most characteristic plant types of the grasslands are composed of the several hundred species of grasses. The Foxtail or Red Brome (*Bromus rubens*) and the Soft Cheat (*Bromus hordeaceus*) are two of the more common types of brome grasses found in the grasslands. The Foxtail grows to about 18 inches and utilizes a dried, prickly seed, which catches in the fur of animals or the clothing of people, as a manner of seed distribution. The Soft Cheat appears as a soft and hairy plant which grows to a height of about 2 feet. The Wild Oats (*Avena fatua*) grows to more than 3 feet and produces lower leaves and seeds which may be eaten by most animals, and if cooked into a mush, is edible by man. Other characteristic grass plants include the Blue Bunch Grass (*Festuca idahoensis*), the California Oak Grass (*Danthocia Californica*), the California Needle Grass (*Stipa pulchra*) and the Velvet Grass (*Holcus lanatus*).

The foregoing list is quite limited as there are numerous grasses, thistles and teasel which have not been mentioned. All of these grassland plants serve several ecological functions. Their fibrous root structures tend to retard soil erosion while the physical and chemical reactions stimulated by the root hairs tend to make soil from rock. The various seeds serve as food for birds and small mammals, and the grass leaves and stems are food for the browsing animals, such as rodents, deer and livestock.

The main trees found in the grassland are the Coast Live Oaks (*Quercus agrifolia*) which is an evergreen, the California Buckeye (*Aesculus Californica*) and the California Laurel (*Umbellularia Californica*). The Laurels growth characteristics vary with moisture and soil depth. The leaf is used as a food seasoning and the oily secretions of the leaf, when deposited on the ground under the tree, prohibits many types of plants. The Monterey Pine (*Pinus radiata*) and the Monterey Cypress (*Cupressus macrocarpa*) frequently grow on the arid, wind-swept slopes and smaller canyons. Both of these trees, in addition to the Blue Gum or Eucalyptus (*Eucalyptus globulus*) with its nut-like fruit, peeling bark and strongly scented leaf odor, have spread from windbreak plantings to favorable locations in some small valleys.

Marsh Lands

Plants growing in this area are affected by the daily fluctuations in the water level of the bay and its salinity and temperature. Most of the land in this area is formed by the accumulation of silt and dust which are compacted by water and wind movement. The daily tidal fluctuations tend to erode poorly compacted areas to cause tidal meanders or channels which are important drainage and boating routes across the bay mud flats. Once the silt is compacted and dried, salt tolerant plants, their seeds born on the wind, water or by birds, tend to accumulate and grow. The marsh plants have the ability to either keep salt out of or to excrete salt from their root system. The root system of the salt-tolerant plants tend to stabilize the silt so that rain can leach out salts to provide some plant zones for less salt-resistant plants.

Some of the more common plants found on the marsh lands are the Salt Grass (*Distichlis spicata*), the Pickle-weed (*Salicornia ambigua*) and the California Cord Grass (*Spartina foliosa*). The Cord Grass is like many marsh plants which produces underground stems that help spread the growing plant and hold the plant to the shallow soil. Low shrub like plants frequently growing in the area are the Sea Blite (*Suaeda californica*), the Marsh Grindelia (*Grindelia hymnalis*) and the Marsh Rosemary (*Limonium commune*).

Scattered along the coast, located in back of the salt marshes are freshwater marshes which may form around springs, ponds, and sluggish streams. These plant zones are characterized by the Common Cat-tail (*Typha latifolia*), the California Bulrush (*Scirpus californicus*), the Common Tule (*Scirpus acutus*) and various species of sedge.

Semi-Barren Lands

Ano Nuevo Point is an area of rocky and sandy beaches subject to wave and tide action, and of sand dunes and bluffs immediately inland. The area is practically devoid of vegetation, but does contain Surf grasses (*Phyllospadix Torregi*), Beach Grass (*Ammophila arenaria*), Tree Lupine (*Lupinus arboreus*), and numerous marine plants.

Resource Potential of The Primeval Setting

The forest economy of the county has been primarily conifer lumber based. However, lumber operations are beginning to utilize logging residue for pulp or in pressing chips into "particle boards" for furniture. There are indications that a potential new resource for flooring and cabinet wood could be local hardwoods which heretofore could not be properly dried for use.

The national demand for forest products is expected to rise steadily with the demand in California to rise even more sharply. The excess of demand over supply will probably be greater in the case of redwoods than for wood generally because of: 1) the restraint of sustained yield operations, 2) the limited areas of commercial forest land available, and 3) the new tendency to utilize redwood for plywood and pulp in appreciable quantities.

The steady flow of timber type land from timber production to recreation, residential and other uses appear to provide a basis for assuming that timber production in the county will be greatly reduced within the next fifty years.

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RECOMMENDED GENERAL POLICIES

The conflicts which arise among man's multitude of purposes in the use of land demand an increasing amount of knowledge on how to avoid impairing the system which sustains human life. The very complex interrelationships and interdependencies of ecological systems establish difficult conditions for analysing regional planning problems and for making sound planning decisions. None-the-less, the foregoing portions of this report have investigated some of these relationships and provide a basis for acknowledging that the ecological systems of the county are highly relevant to all segments of our population.

The following regional planning policies may be concluded from the prior chapters.

POLICIES CONCERNING CLIMATE - (refer to Chapter I)

I-A Climate - general policy

Climate is a natural resource which is affected by the activities of man. The regional planning function should seek to accent climatic amenities and to avoid detrimental climatic changes.

I-B Temperature

Urbanization of land and water areas in San Mateo County can be expected to raise summer high temperatures and lower winter low temperatures. While the magnitude of temperature change in degrees does not appear to be of great significance to the amenities of the climate, it appears quite possible that a temperature change could bring about a change of regional climate which would be detrimental to the fauna and flora of the region. Such changes should be avoided.

I-C Precipitation

Regional planning policies should deal with two aspects of the county's precipitation characteristics: (1) storm water runoff and, (2) water resources.

Policies in regard to storm water runoff will be presented in the following sections on erosion and on drainage and flooding.

I-D Land use in watershed areas

In watersheds the use of the land should be compatible with the quality of water which is drawn off the land. For example, if a watershed is used as a source for drinking water, great care must be taken to assure that the water will not become polluted. If the water is used only for irrigating crops, less restrictive practices need be followed.

I-E Land subsidence and salt-water intrusion

San Mateo County and its cities should pay close attention to the problems of earth subsidence which have been observed for some years in the south-county area. It appears that substantial subsidence has occurred in areas wherein ground-water has been removed or diverted. In other parts of the Bay Region, salt-water intrusion has followed the removal of natural ground-waters. We should take appropriate measures to avoid the problems of land subsidence and of salt-water intrusion.

I-F Water pollution

San Mateo County and its constituent cities should continue their cooperation with the Regional Water Quality Control Board to reduce present sources of pollution, and to avoid future water pollution problems.

I-G Fog and cloud cover

Although man can immediately modify weather, as in the case of fog or cloud dissipation through "seeding", no policies in regard to these activities are suggested here, due to limited knowledge about effect.

I-H Air pollution

The county should continue to support the work of the Bay Area Air Pollution Control District and urge continued research on methods of reducing pollution generators, such as buses, trucks and jet aircraft, and of finding methods of incinerating solid wastes with a tolerable level of air pollutants.

It is acknowledged by many experts that extensive use of private automobiles is the largest single source of air pollution within metropolitan areas. City, County, and Regional governmental agencies should plan for the future development of the San Francisco Bay Region on a pattern which will minimize the use of private automobiles. This can be done by locating places of employment nearby places of residence, and by providing an attractive, convenient, and economical public transit system.

I-I Wind

There does not appear to be very much that man can do, in terms of economic reality to influence the external characteristics of wind. Future planning consideration, however, should denote some consideration to the influence of wind on the design of our subdivisions and cities. Major land development proposals that would make significant changes in the terrain, or its surface, should be carefully analysed prior to any governmental approval. For example, mountains should not be removed, and the bay should not be filled, without full knowledge of the climatic effects of such actions.

POLICIES CONCERNING THE EARTH (refer to Chapter 11)

II-A Landslope

Local governing bodies should take landslope into account when regulating permitted land uses.

High intensity uses should be limited to relatively level areas.

Steeply sloping areas (30 to 50%) should have only low-intensity uses.

Very steeply sloping areas (over 50%) should not be disturbed by any urban activity which requires substantial grading.

II-B Drainage and Flooding

The expansion of the county's population is making the importance of flood prevention more pronounced. It is in the public interest that governmental agencies analyze flood hazards and properly guide land use activities as they relate to drainage and flooding.

II-B-1 Urban development in a watershed basin should be proceeded by a hydrologic study and a drainage plan prepared, so that as each segment of development occurs it will be built to accomodate future drainage requirements.

II-B-2 Natural drainage channels should, whenever possible, be designed so that the beauty of stream beds and shore lines is not marred, and the ecology is not disrupted. Wooded creek-banks should not be replaced by concrete culverts.

II-B-3 Areas subject to flooding should be clearly identified and land uses permitted within the flood plains must be compatible to the hazards of flooding. Local governing bodies should prohibit the construction or reconstruction of public or private facilities in flood areas.

II-C Soils

II-C-1 Any agency, public or private, should have a careful analysis of soil conditions made prior to starting on a land development program. Experience has indicated that it is highly desireable to make this study of the soil during the preliminary planning stages.

II-C-2 Frail lands, subject to severe erosion hazards, low bearing capacity, or severe limitations of percolation should be retained in low intensity type land usage, such as grazing, forestry, recreation and watershed management activities.

II-C-3 Local planning programs should be conducted with awareness of soil erosion problems. The planning of hillside areas, and of the areas lying west of the Skyline ridge should reflect the knowledge gained from the recent studies conducted by the San Mateo County Soil Conservation District.

II-C-4 Due to the severe limitations of soil conditions for septic tank filter fields, San Mateo County should continue its policy of not permitting the development of new subdivisions on septic tank disposal systems.

II-D Earthquakes

II-D-1 Earthquake fault trace areas should be identified and mapped prior to land development. The fault trace should be retained in permanent open space on low intensity land use activities, such as parks, golf courses, timber production or grazing lands.

II-D-2 Urban concentration should be discouraged in areas that have high earthquake risk due to significant shaking hazards, by limiting these areas to very low density developments utilizing earthquake construction techniques.

II-D-3 Public buildings, or the extension of public utilities into high risk areas, should not occur unless recommended by a multi-disciplined reviewing board of earthquake authorities.

II-D-4 Existing building codes should be reviewed to assure that they include adequate performance standards and they should be vigorously enforced.

II-E Landslides

Urban growth in the hill areas of San Mateo County should be preceded by intensive geological studies to provide thorough understanding and consideration of hazardous landslide areas prior to development. Detailed geologic mapping should be a basic prerequisite for the formulation of proper grading plans which can minimize the possibilities of triggering landslides. Those areas found to be of high landslide risk should be retained in permanent open space.

POLICIES CONCERNING THE MINERALS (Refer to Chapter III)

III-A The mapping of non-renewable resources and the establishment of mineral resource zones should be undertaken to avoid pre-empting some deposits by urbanization.

III-B Studies should be conducted seeking methods that might be utilized to allow reasonable extraction activities in urban areas with tolerable levels of disturbance.

III-C Quarrying operations should be planned prior to the issuance of permits so that local jurisdiction can be assured that:

a) they have adequate controls over the operation during the life of the quarrying activity,

b) the quarry site will be left in a safe, attractive and useable condition upon completion of the quarrying operation.

POLICIES CONCERNING THE VEGETATION (Refer to Chapter IV)

- IV-A City, county, and regional planning functions should encourage the preservation of fine old trees and other significant plant resources by seeking to include these plants in permanent open space reserves.
- IV-B Where appropriate, agricultural activities should be encouraged to continue to serve as a base of employment, preservers of open space, and providers of food, fiber and cash crops.

In those areas where the agricultural use of land will be replaced by urban development the planning process should seek to achieve a smooth transition and avoid social and economic disruption to local communities.

- IV-C The San Mateo County Board of Supervisors should be commended for their leadership and for their effective action in establishing Agricultural Land Reserves. This program should be continued, and it should receive continuing study to make it more effective, more equitable, and more attractive.
- IV-D San Mateo County officials should give serious consideration to issuing logging permits only for 'sustained yield' logging operations. Under the 'sustained yield' program a forest environment is retained at all times (i. e.: clear-cutting is not permitted), and the amount of timber removed from the forest is no greater than will grow back on the land within a specified period of time.
- IV-E San Mateo County officials should give serious consideration to modifying the taxation practices on timber resources. If the county were to substitute a 'yield tax', (that is, tax the timber when it is harvested), instead of taxing standing timber, there would be an incentive on the part of the property owner to leave the forest areas standing, rather than logging the land in order to pay the taxes.

It should be noted that the value of standing timber is only a minor fraction of the value of most lands in San Mateo County. However, the timber 'yield tax', when combined with the Agricultural Land Conservation Act, could do much to reduce the economic pressures that timber owners now experience.

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